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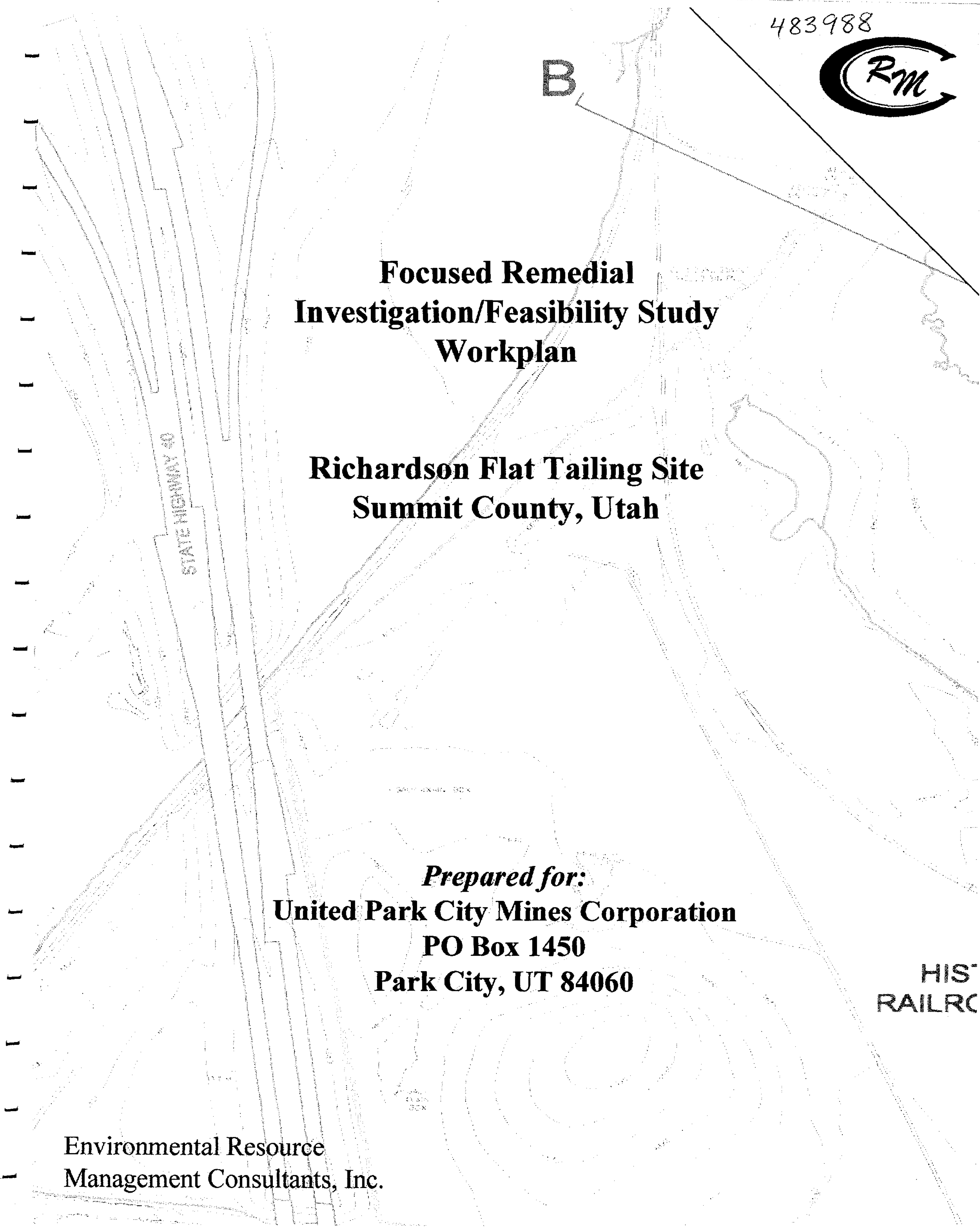

Focused Remedial Investigation/Feasibility Study Workplan

Richardson Flat Tailing Site
Summit County, Utah

Prepared for:

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FOCUSED REMEDIAL INVESTIGATION/ FEASIBILITY STUDY WORK PLAN

RICHARDSON FLAT TAILINGS SITE
SUMMIT COUNTY, UTAH

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1.0 INTRODUCTION

United Park City Mines Company ("United Park") is the current owner of a large parcel of property (the "Property"), comprising approximately 700 acres, located in Summit County, Utah. Figure 1.0 shows the general geographic location of the Property. A historic mine tailings impoundment, consisting of a large, geometrically closed basin formed by an earth embankment and a series of perimeter containment dikes, covers approximately 160 acres of the Property and is sometimes referred to as "Richardson Flat" or simply the "Site." The tailings impoundment resulted from decades of mining and milling silver-laden ore in the area around Park City known as the Park City Mining District. The Site is depicted in Figure 2.0.

The Site has remained unused since mining and milling operations ceased in 1982. Over the past fifteen years, the United States Environmental Protection Agency ("EPA"), the Utah Department of Environmental Quality ("UDEQ") and United Park have been investigating the Site in order to characterize the Site and determine potential adverse impacts to human health and the environment associated with the Site. At the same time, United Park has been implementing a series of remedial measures at the Site intended to mitigate any potential adverse impacts on human health and the environment.

As the result of previous Site operations and United Park's remedial efforts, key elements are in place to support final Site closure. These closure elements include (i) the installation of multiple monitoring wells to monitor groundwater conditions in and around the Site; (ii) the construction of a large, earth embankment and a series of containment dikes to contain the tailings; (iii) construction of a diversion ditch system surrounding the impoundment to collect and redirect surface and ground water; (iv) the placement of a vegetated clay soil cover to isolate the tailings, to prevent tailings from becoming wind-borne, and to minimize the infiltration of water to the tailings; and (v) the installation of a security fence to limit Site access.

Based on available data from the Site and from similar tailings impoundments, United Park believes that the tailings impoundment as currently closed is not having any unacceptable impacts upon and does not otherwise pose unacceptable risks to human health or to the environment. United Park further believes that final Site closure can be achieved without the implementation of further remedial measures. On the other hand, United Park recognizes that EPA has concerns about Site conditions that the agency believes must be addressed through additional Site characterization and possibly through the implementation of additional remedial measures. Therefore, United Park proposes to use the data derived from the proposed, Focused Remedial Investigation and Feasibility Study (together with a focused risk assessment) to determine whether any further remedial measures are needed to support final Site closure. If and to the extent further remedial measures are required at all, United Park believes that any appropriate final remedy for the Site should incorporate to the maximum extent practicable all existing elements of Site closure.

The purpose of this Work Plan is to suggest additional Site characterization work to be performed to assist in the evaluation of additional remedial measures to support final Site closure. To that end, United Park will also perform a focused risk assessment and focused feasibility study, consistent with the Comprehensive Environmental Response, Compensation and Liability Act of 1980 ("CERCLA") and the National Contingency Plan ("NCP") to support final Site closure.

This Work Plan first describes current knowledge about the Site and its history, summarizes investigation and characterization work completed to date, presents a conceptual model of the Site, and describes the additional investigatory, health risk assessment, and feasibility study work United Park proposes to do. This Work Plan also presents a description of the anticipated reports and deliverables and a project schedule.

2.0 SITE DESCRIPTION AND BACKGROUND

The Richardson Flat Property covers approximately 700 acres in a small valley in Summit County, Utah, located one and one-half miles northeast of Park City, Utah. The tailings impoundment Site covers approximately 160 acres in the northwest corner of the Property and lies within the NW quarter of Section 1 and NE quarter of Section 2, Township 2 South, Range 4 East, Summit County, Utah. Figure 2.0 shows the Site boundary.

2.1 Site Operational History

United Park was formed in 1953, with the consolidation of Silver King Coalition Mines Company and Park Utah Consolidated Mines Company, both publicly traded mining companies at the time.

The mill tailings present at the Site consist mostly of sand-sized particles of carbonate rock with some minerals containing silver, lead, zinc and other metals. Tailings were first placed at the Site prior to 1950. While few specific details are known about the exact configuration and operation of the historic tailings pond, certain elements of prior operations are apparent. It appears that from time to time, tailings were transported to lower areas of the Site through three distinct low areas on the Property. Over the course of time, tailings materials also settled out into these three low areas which were ultimately left outside and south of the present impoundment area as constructed in 1973-74. An embankment constructed along the western area of the Site also appears to have been in place as part of the original design and construction of the tailings pond, but few details are known of the original embankment.

In 1970, Park City Ventures ("PCV"), a joint venture partnership between Anaconda Copper Company ("Anaconda") and American Smelting and Refining Company ("ASARCO"), entered into a lease agreement with United Park to use the Property for disposal of additional mill tailings resulting from renewed mining in the area. PCV contracted with Dames & Moore to provide construction specifications for reconstruction of the Site for continued use as a tailings impoundment. The State of Utah approved PCV's proposed Site operations based on Dames & Moore's design, construction, and operation specifications. Before disposing of tailings at the Site, PCV installed a large, earth embankment along the western edge of the existing tailings impoundment and constructed perimeter containment dike structures along the southern and eastern borders of the impoundment to allow storage of additional tailings. *See* Figure 2.0. PCV also installed a diversion ditch system along the higher slopes north of the impoundment and outside of the containment dike along the east and south perimeter of the impoundment to prevent surface runoff from the surrounding land from entering the impoundment. PCV also installed groundwater monitoring wells near the base of the main embankment, as part of the required approval process by the State of Utah.

PCV conveyed tailings to the impoundment by a slurry pipeline from its mill facility located south of the Site. Over the course of its operations, PCV disposed of approximately 420,000 tons of tailings at the Site. In addition to developing construction specifications for the Site, Dames & Moore also provided PCV with operating requirements for the tailings pond and slurry line, that were also approved by the State of Utah as a requirement for operating the Site. Dames & Moore recommended, among other things, that PCV operate the slurry line in such a way so as to deposit tailings around the perimeter of the tailings impoundment and moving towards the center of the impoundment. Unfortunately, PCV failed to follow the Dames & Moore requirement and operated the slurry line in such a way that a large volume of tailings were placed near the center of the impoundment in a large, high-profile, cone-shaped feature. After cessation of operations by Noranda in 1982, the presence of this cone-shaped feature of the tailings pond resulted in the prevailing winds cutting into the tailings and the tailings materials becoming wind-borne. Had the slurry line been operated according to the Dames & Moore specifications, the high-profile tailings cone would not have existed and prevailing winds would not have been a significant potential exposure pathway at the Site.

Between 1980 and 1982, Noranda Mining, Inc. ("Noranda") leased the mining and milling operations and placed an additional, estimated 70,000 tons of tailings at the Site. No new tailings have been placed at the Site since Noranda ceased its operations.

2.2 Description of Existing Closure Measures and Elements

Over the years, certain efforts have been taken at the Site that can be used to support final closure. More specifically, tailings at the Site are presently contained through a combination of man-made and natural factors, discussed below.

2.2.1 Main Embankment and Containment Dikes. As explained above, the majority of the tailings at the Site are contained in a geometrically closed basin, with a large, earth, embankment (the "main embankment") in place along the western edge of the Site. The main embankment is vegetated and is approximately 40 feet wide at the top, 800 feet long, and has a maximum height of 25 feet. (Dames & Moore 1980). The main embankment was designed to permit seepage of water from the impoundment to relieve hydraulic pressure on the embankment. In March of 1974 Dames & Moore recommended to PCV and in November 1980, recommended to Noranda, that engineered seepage controls be installed at the base of the main embankment. Neither company followed this recommendation. A series of man-made containment dikes contain the tailings along the southern and eastern perimeter of the impoundment. The northern edge of the impoundment is naturally high.

In 1980, Dames & Moore investigated the tailings impoundment structures for Noranda and noted that the main embankment may not have been constructed in accordance with its original design specifications and noted that it was oversteepened in some areas. Nevertheless, Dames & Moore did not have any immediate concerns about the stability of the main embankment at that time. While Dames & Moore did express reservations if additional tailings were added to the impoundment over a long period of time, Noranda ceased mining and milling operations in 1982 and no tailings or slurry water have been disposed of at the Site since that time. In light of the cessation of operations, the closure efforts undertaken since 1982, and the passage of some 25 years since its construction, with no signs of stability problems, United Park believes the main embankment is stable.

2.2.2 Natural Underlying Clay Soils. The impoundment is underlain by native high clay-content soils with sufficiently low permeability to support closure in place for the tailings. Existing data demonstrates that there is no hydraulic connectivity between the tailings impoundment and underlying groundwater systems, as discussed in more detail in sections 2.4, 3.4, 4.4, and 5.5, below.

2.2.3 Vegetated Soil Cover. During active operations at the Site by PCV and Noranda, tailings were slurried to the Site, using some 60 gallons of water per minute under normal operations. When Noranda ceased operations in 1982, the tailings pond was, for the most part, full of water and was too soft and unstable to get onto the impounded tailings with heavy equipment. Starting in 1983, United Park began placing soil cover on tailings present outside of the impoundment, located in the three low areas south of the south diversion ditch. *See* Figure 2.0. By 1985, the tailings impoundment had dried out enough in certain areas to support heavy equipment and United Park began installing soil cover material over those portions of the tailings impoundment using soil from both the Park City area and from within the Property. The soil cover consists of clay-rich soil, with kaolinite being the predominant clay mineral. (Weston, 1999).

The soil cover was installed at that time in large part to prevent prevailing winds from cutting into the cone-shaped tailings feature left at the Site by PCV. United Park initially focused its initial efforts on placing soil cover around the cone-shaped tailings feature to eliminate the possibility of wind-blown tailings from leaving the impoundment. Several feet of cover were required in areas around the cone-shaped feature in order to provide for a reasonable final grade of the impoundment. By 1988, work around and on the cone-shaped tailings feature had been completed and other areas of the tailings had begun to dry out enough to support additional work and United Park began a more aggressive program to cover all exposed tailings. Drought conditions during the early 1990s created sufficiently stable conditions to allow United Park to complete the soil cover, even on areas that now support ponded water. At least 12 inches of low-permeability, clay cover material is in place below the north-west area of the impoundment where ponded water is currently present. Currently, there are no areas of exposed tailings material on the Site. The soil cover is also vegetated largely due to United Park's efforts to re-seed the area with appropriate plant species.

The purposes of the soil cover are to isolate the tailings material, to prevent tailings from becoming wind-borne, and to minimize the infiltration of surface water into the tailings materials. Although United Park believes the existing soil cover is sufficient to protect human health and the environment, United Park intends to confirm the areal and vertical extent of the existing soil cover and will evaluate the need for further remedial measures on the soil cover, as described in more detail in section 5.1, below.

2.2.4 Diversion Ditches. A diversion ditch system borders the north, south, and east sides of the impoundment to prevent runoff from the surrounding land from entering the impoundment. *See* Figure 2.0. Precipitation falling on the impoundment area creates the limited volume of seasonal surface water that can be seen on the Site. The north diversion ditch collects snowmelt and storm water runoff from upslope, undisturbed areas north of the impoundment and carries it in an easterly direction towards a low meadow east and outside of the impoundment. This meadow collects drainage from a large area southeast of the impoundment and diversion ditch system. Water from the meadow area is collected in the south diversion ditch system. Additional water enters the south diversion ditch from other areas lying southerly of the impoundment at a point near the southeast corner of the diversion ditch structure. This water consists of spring snowmelt and storm water runoff. Water in the south diversion ditch flows from east to west and ultimately empties into Silver Creek just upstream of Highway 189 near the north border of the Property, although a discrete flow of water to Silver Creek is maintained only during the higher water periods of the year.

In 1992 and 1993, United Park reconstructed the south diversion ditch by decreasing the slope of its banks from nearly vertical to a more gradual slope. United Park also placed a clay soil cover over the re-sloped banks of the south diversion ditch, down to and including areas of the banks underwater. The new banks were then seeded with appropriate varieties and the existing ditch banks are vegetated. United Park did not disturb the bottom of the ditch bed, however. Since doing this work, surface water quality data has shown marked improvement from year to year and the downward trend in metals content measured in the surface water continues to this day. In May, 1999, United Park reconstructed the north diversion ditch along its entire length. United Park also intends to continue to collect surface water quality and sediment characterization data from the south diversion ditch system, as described in more detail in section 5.4, below.

2.2.5 Fencing. In the mid 1980s, United Park installed a fence along most of the Property boundary, including the entire impoundment and much of the property south of the impoundment in order to restrict and control access to the Site. United Park maintains the fence in good repair and United Park intends to continue to do so to control access to the Site until such time as limited access is no longer necessary, consistent with Property redevelopment.

2.3 Regional Geology

The Property lies within the Park City East Geologic quadrangle map as recorded by the U.S. Geologic Survey. *See* Figure 2.1. Geologic maps at a scale of 1:24,000 compiled by Crittenden and others (1966) and by Bromfield and Crittenden (1971) cover this and nearby quadrangles. Bryant (1990) provides a regional 1:100,000-scale map of the area.

The Property is located within a complex fold and thrust belt that was later intruded and overlain by volcanic rocks. Sedimentary bedrock near the Property, dated in the Paleozoic to Mesozoic period in age, is overlain by a thick layer of extruded volcanic rock, dips approximately 25 to 60 degrees to the north, and strikes generally northeast-southwest. (Crittenden and others, 1966; Bromfield and Crittenden, 1971). The Tertiary gravels and volcanic rocks unconformably overlie Mesozoic sedimentary rocks. No known faults exist near the Site.

Tailings on the Site lie on top of alluvial/colluvial sediments that are 30 to 50 feet in depth and are the product of the erosion of the adjacent and underlying volcanic extrusives. Review of borehole data indicates that these sediments are comprised of:

- Two to five feet of soft, organic and clay-rich topsoil
- One to 30 feet of various mixtures of fine-grained silt and clay

- Four feet of sand and gravel
- Variable thickness of highly-weathered, volcanic breccia composed of relatively soft, tight, sandy and silty clay, grading to moderately hard, slightly to moderately fractured volcanic rock

2.4 Regional Hydrogeology

Hydrogeology in the area is characterized by shallow alluvial aquifers located in fine-grained, alluvial and colluvial material, and the deeper, Silver Creek Breccia bedrock aquifer located in the Keetley volcanics. Bromfield and Crittenden (1971) describe this unit of the Keetley volcanics as consisting of intermediate laharic breccias with less common flow breccias and interlayered tuffs. In the subsurface, the weakly consolidated Silver Creek Breccia is interlayered with sedimentary rocks. These sedimentary layers are more numerous toward the base of this unit and consist of quartzite, limestone, siltstone, and shale.

The shallow aquifers are generally encountered from fifteen to thirty feet below the ground surface, in confined and unconfined conditions, and located in gravelly clay. Fine-grained, silty clays cover the top aquifer, and clay and silt separate the shallow aquifers from each other. The shallow aquifer structure appears to be consistent from south of the Site to Silver Creek on its northwest border.

Recent exploratory drilling (designed to better assess groundwater resources for private entities) about 1.5 miles northwest of the Property indicates that the paragenetic relationship between the Tertiary volcanic rocks and associated sediments are complex. Wells located approximately three miles northwest of the Property in Sections 16 and 22, Township 1 South, Range 4 East, Salt Lake Base and Meridian (SLB&M) either flowed to the surface following completion or had shallow static water. These wells indicate that confined to semi-confined aquifers comprise both shallow and deeper aquifer(s) within the Tertiary volcanic rocks and deeper associated sediments. Pump testing and monitoring of water levels in local wells that tap both the shallow and deeper aquifers indicate no apparent hydraulic communication between the shallow and deeper Tertiary volcanic rocks and associated sediments.

The hydraulic conductivity, effective transmissivity, saturated thickness, and effective porosity for the Tertiary volcanic rocks and associated sediments were derived from nearby wells. Controlled aquifer test data are available for wells located in Sections 16 and 22, Township 1 South, Range 4 East, SLB&M. Analysis of data collected from the well indicates that near-well transmissivities approach 110 to 310 ft^2/day with lateral variations in aquifer permeability that both increase and decrease the aquifer's transmissivity. For example, Park City Municipal Corporation (PCMC) recently installed a test well in the southeast corner of Section 34, Township 1 South, Range 4 East, approximately one mile northwest of Property. The well was spudded on the weathered Keetley Volcanics with the underlying Thaynes Limestone as the targeted aquifer. However, the Thaynes Limestone was not encountered at the final drilled depth of 1,000 feet. While the exploratory boring developed water from the fractures in the unweathered Keetley volcanic rocks, the quantity of water that reasonably could be developed from the Keetley Volcanics at this location was between 100 to 200 gpm with long-term drawdown estimated at 250 to 300 feet (specific capacity = 0.33 to 0.4 gpm per foot of drawdown or a transmissivity of 30 to 50 ft^2 /day). This yield was considerably less than the quantity desired by PCMC for a municipal water supply, and the well remains unused. (Hansen, Allen & Luce, 1996).

Generally speaking, the hydraulic gradients in the shallow aquifers roughly parallel topography (i.e., from South to North) except near the southern boundary of the tailings embankment, where the diversion ditch causes the flow to change to the northwest. This northerly bearing orientation of the hydraulic gradient is consistent with regional trends mapped by Brooks and others (1998). Based on the artesian flow observed during the course of drilling the previously described wells located north of the Property, the unconsolidated sediments in this area have a low vertical permeability and local semi-confined to confined conditions.

2.5 Surface Water

Surface water is present at the Site in four areas in and around the Site. First, Silver Creek flows along the west side of the Property, over 500 feet from the main embankment. Second, the drainage ditch system surrounding the tailings impoundment seasonally collects runoff water flowing towards the impoundment and redirects it around the impoundment and into Silver Creek. Surface water is also present in the form of ponded water in the northwestern area of the impoundment, having ponded over the clay soil cover over the impoundment. Finally, very small quantities of surface water are present in the form of a seep located near the base of and near the north end of the main embankment.

Consideration of the fate and transport of the surface waters mentioned above is necessary to understand any impact that the Site may have on surface water quality in the area, including Silver Creek. Because ponded water on the impoundment is derived solely from precipitation falling directly on the impoundment, the volume of ponded water varies from year to year. Ponded water follows several pathways or possible fates from the impoundment. Nearly all water loss can be attributed to evaporation and plant use within the pond. A small amount of the ponded water percolates through the underlying, low permeability soil cover and into the tailings. The ponded water never leaves the impoundment as a discrete surface flow.

The north diversion ditch, running west to east, discharges into the natural meadow area east of the impoundment, where water may ultimately enter the south diversion ditch system, flowing east to west, into a pond and ultimately towards Silver Creek. Surface water in the south diversion ditch in the spring has enough flow to sustain a discrete flow to Silver Creek (or ponded Silver Creek waters). In the later summer when water flows are the lowest, the water flowing from the diversion ditch is difficult to trace to Silver Creek as a discrete flow. Some of the diversion ditch water evaporates and is taken up by plants. The south diversion ditch stops flowing only in the late summer or fall on the easternmost end of the ditch only. The south diversion ditch, however, never completely dries out so it does not appear that diversion ditch water infiltrates into the ground. Weston reports that the diversion ditch serves as a hydraulic sink and may intercept groundwater. (Weston 1999 at 7). For this reason, it appears that late-season flow in the south diversion ditch is comprised of groundwater intercepted by the ditch.

Water from the small seep at the base of the main embankment flows at a very limited rate, in the range of gallons per day. The exact flow rate has not been measured and cannot be calculated without stripping significant amounts of vegetation and organic matter from around the seep area. However, it is clear that due to the low volume of water, a discrete flow is not and cannot be maintained long enough to reach Silver Creek, over 500 feet away. The small amount of water discharging from the seep evaporates in part, is used by plants in part.

3.0 PREVIOUS SITE INVESTIGATIONS

Since the 1970s, PCV, Noranda, EPA, and United Park have conducted numerous environmental investigations relating to the Site. Beginning in the 1970s, PCV conducted groundwater, tailings pond, and embankment design studies focused on whether and how the Site could accommodate additional tailings. In 1980, Noranda conducted studies to determine the current condition of the impoundment and the potential for future enlargement of the impoundment. In the 1980s and early 1990s, EPA conducted studies of groundwater, surface water, and air quality to determine whether Site contaminants posed sufficiently high threats to human health or the environment and to require listing of the Site on the National Priorities List ("NPL"). United Park initially conducted studies focusing on the propriety of listing the Site on the NPL. More recently, United Park has obtained data focusing on the characterization of Site hydrogeology.

EPA has proposed listing the Site on the NPL on two occasions. In 1988, EPA proposed listing the Site on the NPL based on the Site's Hazardous Ranking System ("HRS") score. After considering comments submitted by United Park, EPA ultimately declined to list the Site. By 1992, the HRS scoring system had changed significantly. At that time, EPA rescored the Site and again proposed that the Site be placed on the NPL. Based on the proposed re-listing of the Site, the EPA Emergency Response Branch (ERB) conducted additional investigations on the Site and determined that conditions did not warrant emergency removal action. In 1993, the Agency for Toxic Substances and Disease Registry (ATSDR) found that the Site posed no immediate threat to human health. As before, EPA declined to list the Site, but the Site's listing on CERCLIS remains in effect. While no formal regulatory action has occurred with respect to the Site since the second proposed listing, United Park has continued its efforts to investigate and close the Site by improving the soil cover, maintaining the diversion ditches, and collecting surface water and groundwater data.

This section summarizes past investigation activities and existing Site data. The reports and data from these investigations are very useful in determining the scope of additional investigative activities needed to bring final closure to the Site. From 1985 to 1988 and from 1992 to 1993, the EPA conducted and reported on investigations at the Site.

3.1 Air Monitoring Investigations

Due to concerns over wind-blown tailings resulting from the cone-shaped tailings feature created by PCV, EPA conducted air monitoring investigations on two separate occasions. Due to United Park's subsequent placement of the full, vegetated clay soil cover, data from these investigations are no longer directly relevant but are reported here to support United Park's proposed study of off-Site wind blown tailings.

In 1985, when approximately 40 percent of all of the tailings on the Property had been covered with the soil cover, Ecology and Environment, Inc. ("E&E"), a contractor working for EPA, collected Site air data. Four high volume air samplers were located on or immediately adjacent to the tailings impoundment and one was located approximately one-half mile southeast of the Site. Data were collected at the Site over a five-day period and the filters from the samplers were analyzed for arsenic, cadmium, lead and zinc. A meteorologic station was installed at the Site and wind direction, air temperature, barometric pressure and relative humidity data were collected. The prevailing wind direction measured at that time was from the northwest to southeast. (E&E, 1987).

According to E&E's analytical data, increases were noted for all metals measured in downwind versus upwind monitoring locations. Review of the data in Table 1 of the 1987 E&E report shows that 52% of arsenic, 92% of cadmium, 17% of lead and 14% of zinc measured on the air filters at the Site were below the laboratory's detection limits.

E&E again conducted air monitoring in 1992 at five locations. The installation of the cover within the impoundment had progressed to the point where all of the exposed tailings had been covered, with the exception of one area of tailings where salt grass and other native plant species were growing and had stabilized the tailings. These air monitoring activities showed no detectable levels of arsenic, cadmium or lead. Trace levels of zinc were detected in four of the seventeen samples collected. There are no ambient air quality standards for zinc. The significant reduction in the concentration of target analytes from these two air-monitoring programs can be explained by United Park's efforts to cover the remaining areas of the impoundment. Since 1992, all of the exposed tailings in the impoundment have been covered, including the area where salt grass was growing.

3.2 Tailings Cover Investigations

As part of the EPA ERB investigations in 1992, E&E conducted a survey of the depth of soil cover. E&E measured the depth of cover at 29 locations on a grid pattern of 400 x 400 feet. These locations are depicted on Figure 2, Appendix B. According to the E&E report (EPA 1992), a visual contrast was apparent between the soil cover and the gray colored tailings beneath the cover. X-ray fluorescence ("XRF") measurements for lead were taken at select locations to confirm the visual contrast where the distinction was not clear (see Appendix B, Table 1, for the soil cover data). E&E reported that much of the tailings either had soil or salt grass covering the exposed tailings. Generally, data from the 1992 study shows that the soil cover varied in thickness from less than six inches up to fourteen inches in depth in the areas E&E tested. E&E did not test areas of thick cover areas, where as much as three feet of cover are present. Of the 29 points E&E measured, only one location had no soil or salt grass present. Subsequent to E&E's work, United Park has placed additional soil cover in this and other areas of the impoundment to improve Site closure.

As part of the recent hydrogeologic investigation by Weston (as discussed in section 3.4, below), data were collected on the soil characteristics of the tailings cover. Samples of the tailings cover soil were tested to determine classification and hydraulic characteristics. Soil cover samples were collected from three representative locations over the Site and were tested for moisture content and dry density. Based on this testing, the soil cover was classified as lean clay with sand. Two of the three samples were also submitted for laboratory analysis to determine permeability. Laboratory testing indicated that the cover soil is highly impermeable, with permeabilities ranging from 3 to 7 x 10^{-8} cm/sec. These values roughly correspond to permeabilities typically measured in clay liner systems that are required to be installed at hazardous waste landfills. X-ray diffraction ("XRD") analysis of select samples indicated that the soil cover clay mineralogy closely matched the XRD peaks for illite and kaolinite. Kaolinite was the most prevalent clay mineral and it is stable with little tendency for volume change when exposed to water. Illite is generally more plastic than kaolinite and does not expand when exposed to water. (Weston 1999).

3.3 Studies of Tailings Impoundment Integrity and Stability.

In 1974, PCV hired Dames & Moore to conduct an investigation of the Site and to develop construction specifications for reconstruction of the embankment in order to accommodate the placement of additional tailings materials. While PCV raised and reconstructed the embankment and installed the containment dike system, according to subsequent work performed by Dames & Moore for Noranda, PCV did not appear to follow the design specifications developed by Dames & Moore. In 1980, Dames & Moore conducted an impoundment integrity and stability investigation for Noranda, the then-current operator of the Richardson Flat tailings impoundment. The objective of the investigation was to assess the overall condition and usefulness of the existing facilities and to determine what measures would be required for long-term tailings disposal. (Dames & Moore 1980). Dames & Moore noted several construction flaws during the 1980 investigation, specifically noting that the main embankment was oversteepened in some locations. Dames & Moore concluded that while it did not have any immediate concerns regarding the stability of the main embankment and containment dikes, it did have concerns regarding the use of the Site to dispose of additional tailings.

In 1992, E&E examined the tailings impoundment for EPA. Although E&E noted that the main embankment generally was not constructed according to the 1974 recommendations of Dames & Moore, E&E concluded that there appeared to be no immediate threat of gross failure of the tailings containment structure.

3.4 Groundwater Investigations

In the early 1970s PCV began to collect groundwater data at the Site. Since that time, both EPA and United Park have investigated groundwater conditions at the Site. In 1973, PCV installed three monitoring wells (MW-1, MW-2 and MW-3) at the bottom of the main embankment. In 1976, PVC installed three additional wells (MW-4, MW-5, MW-6). Figure 3.3 shows the well locations. It appears that PCV buried monitoring well MW-2 in 1976 during installation of the three new wells. Thus, five groundwater monitoring wells are located near the toe of the embankment. The boring and well completion logs for these five wells can be found in Appendix D and are summarized below.

- MW-1 was drilled to a depth of 35 feet below the ground surface ("bgs"). Bedrock was encountered from 14.5 feet bgs to the total depth drilled. Well screen and gravel pack were installed from 24 to 34 feet bgs.
- MW-2 was drilled to a depth of 21 feet bgs; bedrock was encountered from 11 to 21 feet bgs. Well screen and gravel pack were installed from 3 to 9.5 feet bgs.
- MW-3 was drilled to a depth of 29 feet bgs; and bedrock was encountered from 5.8 to 31 feet bgs. Well screen and gravel pack were installed from 2.5 to 25 feet bgs.
- MW-4, MW-5, and MW-6 were drilled to 4.0 feet, 6.1 feet and 6.1 feet bgs, respectively. Boring and completion logs for these wells are not available.

Since 1973, PCV and later, United Park, have collected data quarterly from these embankment wells. Table 3.2 presents groundwater data collected by United Park from 1982 to 1987 and 1991 to 1998 from these monitoring wells.[1]

[1]Groundwater data from the main embankment wells for the years 1988 to 1990 are not readily available to United Park and as a result are not reported herein. United Park is attempting to locate data from 1988 to 1990 and will report it as part of the RI/FS Report, discussed below.

In 1985, E&E collected groundwater samples from one upgradient well and two wells located downgradient of the main embankment.[2] E&E installed the upgradient RT-1 monitoring well. The two downgradient wells were existing wells installed by United Park or PCV around 1974 and 1975.[3]

In 1992, EPA hired E&E to conduct an additional groundwater investigation. The 1992 groundwater data collected revealed a similar trend as shown in the 1985 E&E study. E&E collected groundwater samples from the Site at three locations, referred to as RF-GW-04 (EPA well RT-1), RF-GW-05 (United Park location MW-1) and RF-GW-09 (United Park location MW-6). Table 3.3 compares the data collected by EPA in 1984 and 1992 with data collected from the same wells by United Park in 1998.

In 1999, United Park hired Weston Engineering, Inc. ("Weston") to conduct a supplemental hydrogeological investigation of the Site. This study represented the most extensive groundwater investigation conducted to date to better understand groundwater systems on the Property. Weston evaluated historical Site and regional data to derive a hydrogeological conceptual Site model (see Appendix A). In the course of its investigation, Weston also installed

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[2]According to the E&E sampling report, United Park wells MW-1 and MW-2 were sampled. However, this was not the case: MW-1 was most likely sampled and MW-5 or MW-6 were sampled since MW-2 was believed to have been buried during the installation of MW-4, MW-5 and MW-6 (see Plate 1, Appendix A). United Park's 104(e) response to EPA in 1988 did not contain data for MW-2. The data record submitted to EPA covered the time period from 1982 to 1987. Therefore, E&E could not have sampled MW-2 at that time.

[3]While E&E compared the upgradient and downgradient metals concentrations in order to determine if the tailings materials were impacting groundwater beneath the impoundment, comparison of this data is not appropriate. Further analysis of the well completion logs for RT-1 and MW-1 compared to the total depth of wells MW-5 or MW-6 reveals that RT-1 was screened in both the upper and lower shallow aquifers. MW-1 is screened in the bedrock aquifer and wells MW-5 and MW-6 are screened in the vadose zone. Comparing data from these wells is not accurate since all the wells are completed in different aquifers. E&E reported that downgradient metals concentrations were elevated as compared to upgradient concentrations. However, in 1985, only manganese exceeded National Interim Primary (NIP) drinking water standards. (E&E 1985).

eleven additional piezometers throughout the Property (see Plate 1, Appendix A). Boring logs from the piezometer installation verified the existence of two aquifers associated with the Property. Water level data collected from the piezometers indicates that the two aquifers are confined and are separated from one another by a significant layer of stiff, clay-rich material. The upper aquifer is overlain by approximately 15 feet of reddish-brown mixtures of silt and clay. An additional two to five foot layer of clay-rich soil overlies this layer of clay-rich material. (Weston, page 4). The local geology has greatly influenced the types of soils that have developed on the Property. The altering and weathering of Keetley volcanics, which form the surrounding hills, have provided the source material for soil development. The abundant clays that result from the alteration and weathering of the Keetley volcanics form the bulk of the natural alluvial material as well as the soil within the Property. Percolation tests conducted on this volcanic soil that was borrowed to cover the tailings within the impoundment indicates that it has very low permeability, 3 to 7 x 10^{-8} cm/sec. Water level data collected after the installation of the piezometers and subsequent water level measurements indicate that the water levels in the two aquifers varies seasonally, with higher water levels occurring in the Spring.

The data reported by Weston was not available to the previous Site inspection teams and other agencies that previously evaluated the Site. Earlier studies by Dames & Moore identified the presence of clays in the naturally-occurring material at the Site. It was not until Weston's investigation that extent or the significance of the natural clay material underlying the Property was known. The existence of two to five feet of clay-rich topsoil and the presence of the large area of silt and clay that overly the upper aquifer represent a significant barrier to the vertical migration of any water from saturated tailings.

3.5 Investigations of Surface Water Quality

United Park has collected surface water quality data at the Site since 1975. Data from 1982 to 1988 are presented in Table 3.1. Samples were collected upstream and downstream of the area of confluence of the main (south) diversion ditch with Silver Creek. Also, samples were collected from the water that runs in the diversion ditch as it passes through the Site. Figure 3.1 shows the sample locations. Table 3.4 presents data on water samples collected in 1999 to evaluate surface water quality in the main diversion ditch and in Silver Creek. Figure 3.3 shows the 1999 sample locations.

A review of the historical and recent data from these three sampling points demonstrates that since the time that United Park's re-grading and covering of the banks of the south diversion ditch (1992-1993), water quality has steadily improved both in the south diversion ditch at the point where it leaves the Site and in Silver Creek below the Site. *See* Figures 3.2 and 3.2a. The data also demonstrates that although some metals are present in upgradient areas in the south diversion ditch, by the time the water discharges to Silver Creek, metal levels have decreased significantly.

4.0 CONCEPTUAL SITE MODEL

Based on previous and current environmental studies and existing Site conditions, United Park has developed a conceptual model of the Site. The Conceptual Site Model will be used to evaluate the need for further remedial measures to support final Site closure. This model is described below and graphically portrayed in Figure 4.0.

4.1 The Tailings Impoundment

The tailings impoundment can be visualized as a semi-rectangular shaped, geometrically closed basin, with a man-made main embankment and perimeter containment dike system along three sides and a natural sloping surface forming the fourth side. *See* Figure 2.0. The main embankment is located along the western dimension of the impoundment. The tailings impoundment structure isolates and contains variably thick, slimy and sandy mill tailings materials. The impoundment is covered with high clay-content, vegetated soil. The tailings have been deposited on thick layers of native, clay-rich soils. Metals present in the tailings material are the primary potential sources of contaminants at the Site. Geochemical data collected during air monitoring conducted in 1984 by E&E for the EPA characterize the tailings as metal sulfide materials. Such compounds, when found in a neutral pH environment such as exists at the Site, are not easily degraded and are particularly stable.

The clay-rich soils underlying the impoundment formed the original ground surface topsoil materials that existed at the Site prior to tailings deposition. Permeability data reported by Weston indicate that these clay soils have a low hydraulic conductivity, ranging from 0.001 to 5 ft/year. The clay soil cover materials have permeabilities ranging from 0.031 to 0.072 ft/year. (Weston, Table 1, page 7, 1999). A diversion ditch system prevents most storm water from entering the impoundment from off-Site sources, as explained more fully below in Section 4.3.

4.2 Other Tailings Materials

Some tailings materials are present outside of the current impoundment area. During historic operations of the tailings pond, tailings materials of varying thickness accumulated in three naturally low areas leading to the meadow property that eventually became the impoundment.

In the 1970s, when PCV constructed the perimeter dike and diversion ditch along the south perimeter of the impoundment, tailings present in the three low areas were left in place, outside of the present impoundment. Starting in 1983, United Park covered most of these tailings outside of the current impoundment with the same kind of low permeability, vegetated soil cover United Park also placed over the tailings impoundment. Other types of clean fill material, imported from construction work in Park City, was also used to cover the tailings outside of the impoundment. Because these areas were naturally low, the cover in some of these areas is as thick as 10 to 15 feet. The same underlying, natural soil conditions exist in these locations as beneath the impoundment.

As explained more fully in Section 5.2, below, United Park will estimate the areal and vertical extent of tailings outside of the impoundment. United Park will also study any adverse impacts the tailings materials may be having on surface water in the south diversion ditch. With this information, United Park will evaluate the necessity and the feasibility of excavating these off-impoundment tailings and cover materials and placing the same within the impoundment.

4.3 Surface Water

As noted above, surface water is present at the Site in four areas in and around the Site. First, Silver Creek flows along the west side of the Property, over 500 feet from the main embankment. Second, the drainage ditch system surrounding the tailings impoundment seasonally collects runoff water flowing towards the impoundment and redirects it around the impoundment and towards Silver Creek. Surface water is also present in the form of ponded water in the northwestern area of the impoundment, having ponded on the surface of the clay soil cover. Finally, very small quantities of surface water are present in the form of a seep located near the base of and near the north abutment of the main embankment.

Ponded water on the surface of the soil cover within the impoundment is derived solely from precipitation falling directly on the impoundment. The amount of water ponding on the surface of the impoundment varies from year to year. Ponded water follows several pathways or possible fates from the impoundment. Nearly all water loss can be attributed to evaporation and plant use within the pond. A small amount of the ponded water percolates through the underlying, low permeability soil cover and into the tailings. The ponded water never leaves the impoundment as a discrete surface flow. It is highly unlikely that surface water would ever fill the basin within the impoundment. Even if large amounts of water ended up on the impoundment for some unlikely reason, studies indicate that the area within the impoundment has sufficient capacity or "freeboard" to contain the 100-year/24-hour precipitation event, thus eliminating the possibility of overtopping. (Dames & Moore 1980; Alliance Engineering 1999). But even if the tailings impoundment were to ever overfill with water for some unlikely reason, excess water would flow to the lower, east end of the containment dike system, near the east end or point of origin of the south diversion ditch system. Water from an overtopping event would not flow west across or cut into the main embankment.

The north diversion ditch, running west to east, discharges into the natural meadow area east of the impoundment, where water may ultimately enter the south diversion ditch system, flowing east to west, towards Silver Creek. Water from the south diversion ditch flows west and collects in a pond located in a historic excavation where materials were removed for use in the construction of the main embankment during 1973-74. The grade of the south or main diversion ditch is low and therefore the velocity of water flowing through the ditch is not of concern. Where higher water velocities do occur in the ditch, rip-rap or vegetation is present to minimize any potentially adverse impacts to the ditch banks due to erosion. The ditch is well-vegetated by common wetland species such as cattails and willows. This vegetation helps to buffer the banks from erosion and also serves to decrease water velocity, thereby eliminating potential erosion problems.

Surface water in the south diversion ditch in the spring has enough flow to sustain a discrete flow to Silver Creek (or ponded Silver Creek waters). In the later summer when water flows are the lowest, the water flowing from the diversion ditch is difficult to trace to Silver Creek as a discrete flow. Some of the diversion ditch water evaporates and is taken up by plants. As noted above, the south diversion ditch never completely dries out and it does not appear that diversion ditch water significantly infiltrates into the ground. If the diversion ditch is acting as a hydraulic sink, it may also be intercepting groundwater.

The small seep at the base of the main embankment generates a very small flow of water, in the range of gallons per day. Due to the low volume of water, a discrete flow is not and cannot be maintained long enough to reach Silver Creek, over 500 feet away. The existence of the seep is consistent with the design of the tailings impoundment. As noted above, the main embankment was designed to allow seepage as necessary in order to alleviate the build-up of hydraulic pressure from within the impoundment. No data indicate or even remotely suggest that a potential soil piping failure may occur at the point of the seep. The physical characteristics of the seep have remained constant since it was first observed at the Site. Seepage water has not been observed to carry sediment and has been occurring at a very low flow rate that has not increased over time.

While seasonal runoff water from the south diversion ditch reaches Silver Creek during the spring and summer months of the year, United Park believes that the data establishes that water quality in the south diversion ditch has been steadily improving for the past decade, particularly after United Park completely covered the tailings inside of the impoundment and re-graded and covered the banks of the south diversion ditch in 1992. This trend toward improved water quality not only reflects United Park's remedial efforts taken at the Site, but also the change in Site conditions from the more dynamic status as an operating tailings pond (receiving hundreds of thousands of gallons of water and thousands of tons of tailings per week) to a large parcel of land that only receives water from snow melt or rain.

In addition, recent water quality data provides sufficient parameters upon which United Park has developed a metals loading model, described in detail in Appendix C. This model has essentially calculated waste loads to Silver Creek from the diversion ditch and embankment seeps under three different scenarios. First, it is assumed that Silver Creek meets ambient water quality ("AWQ") standard for zinc. Modeling is then completed on the diversion ditch and the main embankment seep to determine what the metals loading in these two sources of water would have to be in order to assure that Silver Creek does not exceed standards. Second, modeling is done using actual values for both the seep and diversion ditch. The actual metal concentrations in Silver Creek are calculated in this scenario. The third scenario makes the assumption that Silver Creek contains no zinc or 0.00 mg/l.

Using available data, the modeling calculations establish that any metal load concentration contributions made by the south diversion ditch and, potentially, by the main embankment seep, do not adversely impact Silver Creek, even when Silver Creek is presumed to contain no metals. Stated differently, the load contribution to Silver Creek from the south diversion ditch (and to the extent relevant, from the main embankment seep) is not significant enough to cause the quality of the water in Silver Creek to exceed surface water quality standards for the State of Utah, even if it is presumed that Silver Creek contains no metal. In summary, by utilizing waste-load calculations similar to those used to determine the effect an NPDES permitted discharge would have on a receiving stream, it can be shown that the south diversion ditch and main embankment seep do not have enough flow or metal loading to cause Silver Creek to exceed water quality standards. United Park recognizes that water quality in Silver Creek does not meet the standards for a variety of uses. However, zinc concentrations observed in Silver Creek are not a result of waters flowing from the south diversion ditch and the main embankment seep from the Site.

4.4 Ground Water

Recent and historic data establishes that there are at least four shallow groundwater systems associated with the Richardson Flat area generally:

- The impounded tailings
- Relatively shallow alluvium with possibly a perched water table
- Deeper alluvium composed of confined sand and gravel aquifer(s)
- The underlying and adjacent fractured Keetley volcanic rocks

(Weston 1999, page 2).

Tailings were originally placed on native, clay-rich topsoil that was the original ground surface prior to the deposition of tailings. (Weston, 1999; *see* Figure 3.0). Water is also present in the tailings due to limited percolation of storm water and snowmelt through the existing soil cover. Due to the low permeability that is attributed to the high clay content, the underlying clay soils effectively create a barrier to the vertical movement of ground water from the tailings impoundment to the underlying shallow alluvial or bedrock aquifers. (Weston 1999; Dames & Moore, 1974).

Within the immediate area of the impoundment, groundwater flow in the bedrock aquifer monitoring well (MW-1) is reported as quite low. (Dames & Moore, 1973). Based on limited but useful data, the groundwater flow in the deeper volcanic bedrock aquifer does not appear to be significant, either. Weston reported (*see* Appendix A, page 3) that a test well located approximately one mile northwest of the Site was completed to a depth of 1,000 feet into the volcanic bedrock aquifer. The well produced insignificant water for use as municipal water supply. Transmissivities ranged from 30 to 50 ft^2 /day for this well.

4.5 Identification of Potential Contaminant Migration Pathways

Based on data collected to date, United Park has identified three potential contaminant migration pathways. First, releases to the air as the result of wind-blown dispersion of tailings materials occurred in the past. This pathway has been eliminated because the tailings within the impoundment are covered with a soil and vegetative cover. Existing data suggests that the high clay-content soil cover is relatively impermeable, is stable, and is suitable to prevent direct contact with, and wind dispersion of, the tailings materials. United Park proposes to conduct additional field work to confirm the thickness and effectiveness of the soil cover in order to determine whether additional remedial measures are needed to achieve final site closure, as described in more detail in section 5.2, below.

Second, United Park understands that EPA has raised concern over potential releases to groundwater as the result of leaching metals from the tailings and hydraulic connectivity between saturated tailings and Site groundwater systems. Tailings materials and the substances leached therefrom would be the primary source of potential contamination to the ground water. The potential exposure route for terrestrial or aquatic biota would be ingestion of surface water that has been affected by contaminated ground water.

This second potential contaminant migration pathway is inconsistent with existing, natural Site conditions. Low-permeability, native clay soil is continuous beneath the impoundment, as illustrated in Figure 4.0. Mineralogical data on the underlying soils indicate that the clay layer is comprised of a mixed clay mineral (i.e., mixed mica and illite or smectite). Based on recent studies by Weston, United Park believes that existing data establishes that it is unlikely that leached metals would migrate through the significant clay soil layer and into the underlying shallow aquifer because of the low permeability of the soil layers underlying the tailings. The tailings are derived from mineralized bodies that are hosted in carbonate or carbonate-rich rocks. These materials have a high buffering ability to counter any acid that might form as the result of sulfide degradation. Finally, there are no drinking water wells completed in the shallow or deep aquifers on or near the Site.

The third potential contaminant migration pathway consists of releases to surface water as the result of leaching of metals from the tailings materials. As with groundwater, tailings materials are the primary potential source of contamination of surface water. With the possible exception of the bottom of portions of the south diversion ditch and the small amount of water discharging from the seep at the base of the main embankment, surface water does not come into direct contact with the tailings materials. While a potential contamination pathway to surface water exists in portions of the south diversion ditch and in the seep at the base of the main embankment, existing data also suggests that neither pathway is having any adverse impact on the water quality or the general water chemistry, including zinc concentrations, in Silver Creek. Nevertheless, United Park will conduct additional surface water characterization work to further evaluate the condition of the southern diversion ditch and to evaluate any impacts caused or potentially caused through the surface water contaminant migration pathway, as described in more detail in section 5.4, below.

5.0 SUPPLEMENTAL REMEDIAL INVESTIGATION WORK

As summarized in section 3, above, extensive investigation work has already been completed at the Site. Moreover, over the years, United Park and others have taken actions to bring closure to the Site, including the installation of a soil cover over the tailings, drainage ditches, and a security fence. In order to evaluate the need for any further remedial measures to support final Site closure, United Park proposes conducting the following remedial investigation work. This Section describes and discusses the rationale and scope of the proposed work, including a description of applicable data quality objectives.

5.1 Tailings Cover Investigation

Since 1983, United Park has been placing soils over the impounded tailings in an effort to control wind-blown dust from exposed tailings. The tailings are now entirely covered with a vegetated, clay soil cover. Additional studies on the tailings cover will gather data to support evaluation of the following: (i) the minimization of surface water infiltration into the tailings embankment; and (ii) the adequacy of existing cover to support final site closure, consistent with contemplated future redevelopment of the Site and the adjacent Property. To that end, United Park will gather sufficient supplemental data in order to:

- Confirm the lateral and vertical extent of the existing tailings cover
- Determine the technical specifications for any additional cover, if needed
- Determine the specifications for suitable borrow material
- Determine revegetation requirements, if needed
- Determine surface grading requirements to improve drainage

United Park will confirm the lateral and vertical extent of the soil cover by using data collected by E&E in 1992 as a baseline and collecting new soil samples on a 500 by 500 foot grid. Following procedures similar to those E&E used in 1992, United Park will dig shallow excavations either with shovels, hand augers or backhoes, if necessary, until the tailings are exposed. Visual observations of the contact between the cover soils and tailings will be used to document the depth of the soil cover at each grid point. The tailings materials are sufficiently different in grain size and color from the cover materials to permit use of a visual identification method to differentiate between tailings and the soil cover. The cover soils are characteristically identified as a reddish-brown clay material while the tailings are characterized as a gray silty-sand material. Verification of the visual method will be conducted by collecting samples at ten-percent of the sample points and submitting them for laboratory analysis. The samples will be collected from the cover material just above the tailings interface and will be analyzed for metals noted in the Analytical List for soils shown in Table 5.2. Figure 5.0 shows the sampling grid, and Figure 2 in Appendix B shows the 1992 sample locations.

Based on the results of the sampling, United Park will evaluate (i) the need for additional cover material to supplement existing cover (including but not limited to evaluation of soil type, thickness, permeability, and compaction requirements); (ii) vegetation and revegetation requirements; and (iii) surface drainage requirements.

5.2 Off-Impoundment Tailings Investigation

Tailings are present in three naturally low areas south of the present south perimeter containment dike and south diversion ditch. United Park proposes to use historical aerial photographs to determine the areal extent of off-impoundment tailings materials. United Park will also estimate the vertical extent of tailings and cover material using existing historical information and limited borehole data. United Park will also drill limited boreholes to determine whether shallow groundwater is moving through these tailings and is potentially intercepted by the south diversion ditch.

United Park will use this additional data to determine the approximate volume of tailings located south of the impoundment, whether these tailings are having any potential, adverse impact on the water quality in the south diversion ditch. United Park will further use this information to determine whether the tailings presently located to the south of the impoundment need to be excavated and placed within the impoundment. United Park will also use the information to estimate the costs of excavation of the off-impoundment tailings (and associated cover), placement of the same within the impoundment, and installing additional soil cover as needed. Should these studies indicate that the tailings located south of the impoundment must be relocated, United Park will also evaluate the potential geotechnical impacts excavation may have on the areas lying along the south diversion ditch.

5.3 Wind-Blown Tailings

As previously discussed, prior to United Park's placement of a soil cover over all of the tailings, some of the tailings material may have been blown by the wind to areas near the Site. The areal extent of any wind-blown tailings has not been fully addressed in prior studies. EPA has requested that, as part of the remedial investigation work, United Park determine the areal extent of any such wind-blown tailings.

United Park will conduct soil sampling to determine the areal and vertical extent of wind-blown tailings. Sampling transects, 3,500 feet long, will be established in field with the following criteria:

- One sample transect will be placed perpendicular to the tailings impoundment, approximately 500 feet north of the main embankment
- Two sample transects will be placed beginning 500 feet south of the county road and a second transect at a 500-foot interval

United Park will collect soil samples at 500-foot intervals along the transects and at a depth of 0-6 inches. The samples will be analyzed for the soil parameters listed in Table 5.2. Figure 5.1 shows the proposed location of the transects and sample intervals.

Data collected from wind-blown tailings will be used to determine whether any remedial action will be necessary.

5.4 Surface Water

Surface water is present at and near the Site, primarily in the south diversion ditch system and in Silver Creek. As noted above, elevated metal concentrations have been detected in the south diversion ditch, which not only decrease in concentration as the water flows towards Silver Creek but overall have also decreased in concentration during the last several years. Despite significant existing surface water quality data, previous surface water quality investigations did not analyze sufficient parameters to be useful in United Park's metal loading model. Additional surface water data will be collected specifically for use in the metal loading model. Expanded surface water characterization data will be gathered for one year to determine whether the data varies with changing seasons. In addition, United Park will collect a series of sediment samples from the south diversion ditch in order to more accurately characterize the bed of the south diversion ditch.

In addition, more precise water flow information is needed for the metal loading model. To gather precise flow information, United Park will install a twelve-inch parshall flume on the south diversion ditch downstream of the pond. The flume will be used to measure flow in the diversion ditch upstream from the location where it enters the wetland area and Silver Creek (location RF-6). Two smaller flumes, nine inches at the throat, will be installed at upstream locations on the south diversion ditch. Flow measurements in Silver Creek will be determined just upstream of sampling station FR-7-2 by using a current meter and standardized measurement methods for open channel flow determinations. Flume installation on Silver Creek proper is difficult due to a variety of issues outside of United Park's control. Accurate flow information cannot be gathered at the downstream confluence of Silver Creek and the diversion ditch due to dispersed flow through the wetland area. Water flow at RF-8 in Silver Creek will be determined by adding the flow measured at RF-6 and RF-7-2. The flow at RF-7-2 will be determined using a float or pygmy meter. Figure 3.3 shows the proposed flume locations.

Insufficient data currently exist to determine whether the metals loading modeling that United Park has developed adequately characterizes conditions throughout the entire year. Therefore, the surface water monitoring program will be performed to collect 12 water samples on a monthly basis at the following locations: RF-2, RF-3-2, RF-6, RF-7-2 and RF-8 (see Figure 3.3). As shown in Figure 3.3, RF-3 will be moved to a new location to allow for the installation of a parshall flume. RF-3 will be renamed RF-3-2. The samples will be analyzed for the water parameters listed in Table 5.2. After data has been gathered from the 12 monthly samples, United Park's model will be refined using the new information.

While more precise flow rate data from the main embankment seep may be useful, a significant amount of existing vegetation and organic matter, grown during the last ten years or so, would have to be removed before flow data can be obtained. Because United Park believes that the existing natural conditions are very likely mitigating any dissolved metals present in the water from the seep, United Park is reluctant to propose disturbing existing conditions at this time. Nevertheless, United Park does intend to collect monthly samples, winter weather permitting, of surface water from the main embankment seep area in order to better characterize water quality and concentrations of dissolved metals. The presence of significant amounts of snow, in addition to organic matter and vegetation, may render sampling of the water from the main embankment seep impossible during certain winter months, however.

5.5 Groundwater

The hydrogeologic conceptual model prepared by Weston will be used as the basis of further work on refining the understanding of groundwater conditions at the Site. As part of its study, Weston installed 11 new piezometers. Additional piezometers are not needed to gather necessary data. Groundwater elevation data is currently collected on a monthly basis to determine whether seasonal groundwater fluctuations exist. This sampling will occur through another runoff cycle or until the end of the last quarter of 2000. The data from these measurements will help determine the dynamics of the groundwater system at the Property. A report will be drafted upon completion of the data collection process that addresses any changes in the groundwater levels.

United Park will also conduct additional testing to characterize the seep water chemistry and flow rates to determine whether the main embankment seep is having any adverse impact on the water quality of Silver Creek.

As noted by EPA in its informal review of the Weston report, additional information is required to refine the Site's water balance. Monthly water levels will be collected from the piezometers installed by Weston in and around the impoundment. The groundwater level data will be collected in conjunction with the surface water monitoring. Groundwater and surface water elevation data will be collected at paired locations such as RT-5 and the south diversion ditch, at RT-7, and at Silver Creek. The data will be used to quantify the surface water-groundwater interaction.

Finally, groundwater monitoring well RT-1 should be abandoned because it was completed both in the shallow confined and unconfined aquifers. Based on the well construction, cross flow between the two aquifers may be occurring. According to state well construction regulations, such construction is not allowed without prior approval. United Park will prepare a closure plan for the EPA RT-1 monitoring well, proposing that the well be grouted with a bentonite seal to within five feet of the ground surface and that the casing removed to below grade.

5.6 Quality Assurance Project Plan

As part of the focused RI/FS, United Park will develop a Quality Assurance Project Plan ("QAPP") to assure that sufficient data of acceptable quality are collected to achieve United Park's final Site closure goals outlined herein.

6.0 FOCUSED RISK ASSESSMENT

Using data from the focused remedial investigation and from prior investigations, United Park will develop a focused risk assessment to determine whether Site conditions pose an unacceptable risk to human health or to the environment which would require additional remedial measures.

7.0 FURTHER REMEDIAL ACTION

Based on available data from the Site and from similar tailings impoundments, United Park believes and existing data demonstrates that the tailings impoundment as currently closed is not having any unacceptable impacts upon and does not otherwise pose unacceptable risks to human health or the environment. United Park further believes that final Site closure can be achieved without the implementation of further remedial measures. The Site is similar in construction and characteristics to other tailings impoundments found throughout Utah and other Rocky Mountain states. The tailings on this Site are non-reactive and were derived from ore bodies contained in carbonate host rocks. Soil, surface water, and groundwater media will be addressed in both the additional investigative work and in the evaluation of further remedial measures. Recent and past investigations show that the tailings are underlain by native high clay content soils, sitting within an enclosure constituting a large, geometrically closed impoundment, covered with a complete and vegetated soil cover. There is a surface water diversion ditch system that surrounds the impounded tailings. Available hydrogeologic and groundwater monitoring data indicate that the tailings are not affecting the underlying ground water.

Because the characteristics of the Site are similar to other tailings impoundments in the Rocky Mountain region, much is known about such sites generally and about the effectiveness of such an impoundment's construction. But even more important here, many elements are already in place to support final Site closure, as described above in section 2.2.

United Park proposes to use the data derived from the focused remedial investigation and information from the focused risk assessment to determine whether any further remedial measures are needed to support final Site closure. If necessary, United Park will develop appropriate remedial action objectives as part of the feasibility study.

If and to the extent further remedial measures are required at all, United Park believes that any appropriate final remedy for the Site should incorporate to the maximum extent practicable all existing elements of Site closure, and where necessary and appropriate, should adopt additional measures to improve Site closure. Such additional measures, if required, may include:

- Improving and maintaining the main embankment stability and integrity
- Improving and maintaining the soil cover
- Improving and maintaining the surface drainage
- Improving and maintaining the diversion ditches
- Excavating tailings located outside of the impoundment, placing the same within the impoundment, and placement of additional cover
- Establishing appropriate institutional controls to prevent unacceptable exposure risks

Evaluation of any further remedial measures to support the final Site closure will include an assessment of the feasibility and overall effectiveness of such measures based on the requirements of CERCLA and the NCP, including a risk screening assessment based on possible future land use scenarios. Contaminants of concern, potential pathways of exposure, and possible receptors will be identified and evaluated. At the outset of the focused feasibility study, ARARs for the final Site closure will also be identified. Since the range of possible future land uses will be set out early in the process, the proposed ARARs will be focused on a narrow range of remedial measures to support final Site closure.

United Park notes that it is currently considering long-term, non-residential land uses at the Site and the Property. While the Property outside the impoundment is already suitable for development, the Property is not currently being used for any productive purpose. United Park is considering developing the area outside of the actual impoundment for non-residential, recreational uses. United Park is also considering non-residential uses, consistent with the soil cover and any appropriate institutional controls, for the southern area of the tailings impoundment area itself.

Finally, United Park will present the results to the EPA in an RI/FS Report, including any recommended remedial measures to support final Site closure.

8.0 DELIVERABLES

United Park will prepare a RI/FS Report that will present analytical data collected during the focused remedial investigation and an interpretation of the data in relation to human health and environmental exposures. It will address the following topics:

- Site characteristics
- Site physical characteristics
- Source characteristics
- Nature and extent of contamination
- Contaminant fate and transport
- Streamlined risk evaluation

United Park will also prepare an appropriate Quality Assurance Project Plan prior to fully implementing the work proposed in this Work Plan.

9.0 SCHEDULE

United Park will develop a schedule to guide the work proposed in this document using the Critical Path Method (CPM). Negotiations with the EPA over the administrative agreement will determine the initiation date for the focused RI/FS and will define roles and responsibilities for its completion.

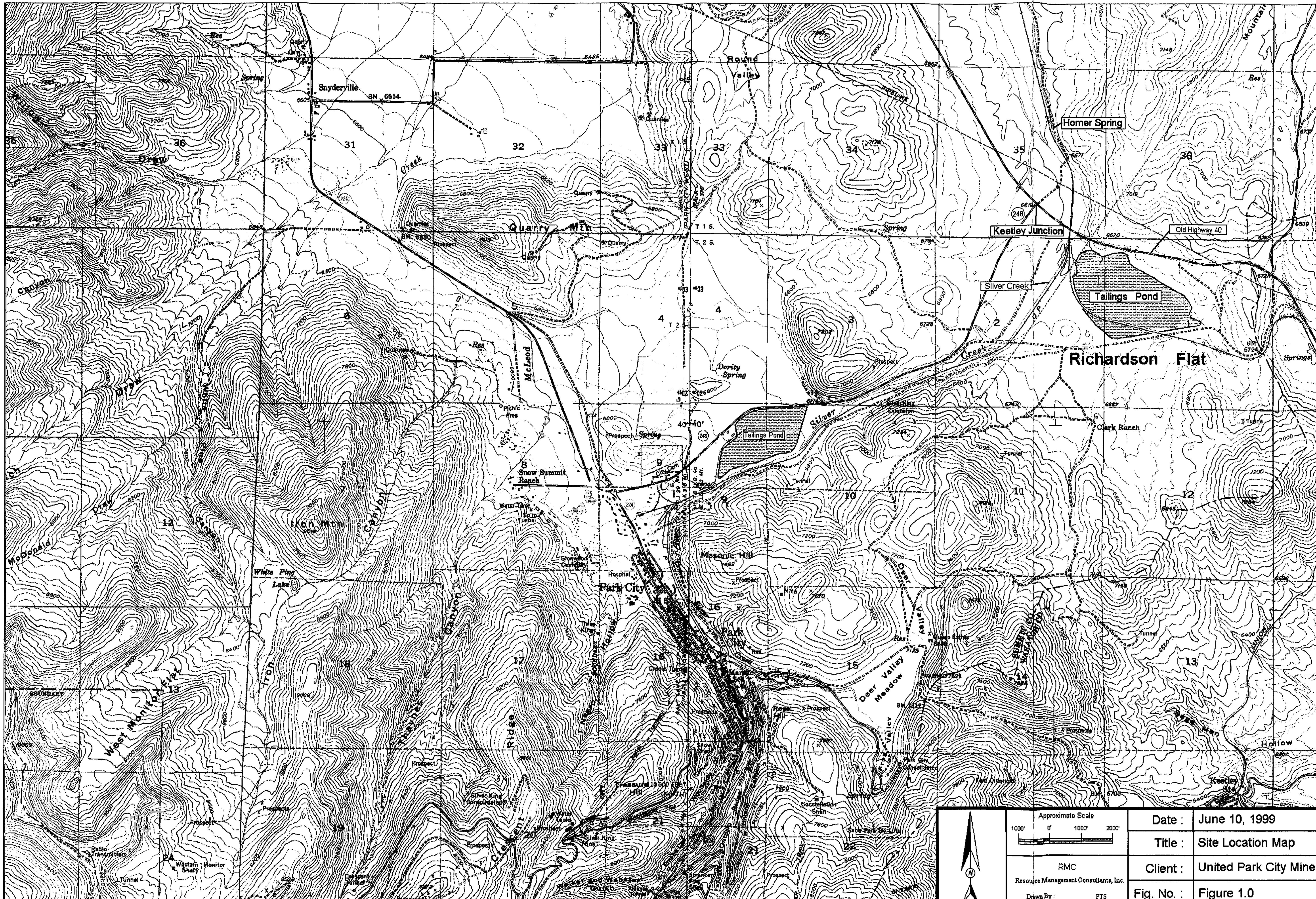
10.0 PUBLIC NOTICE AND COMMENT

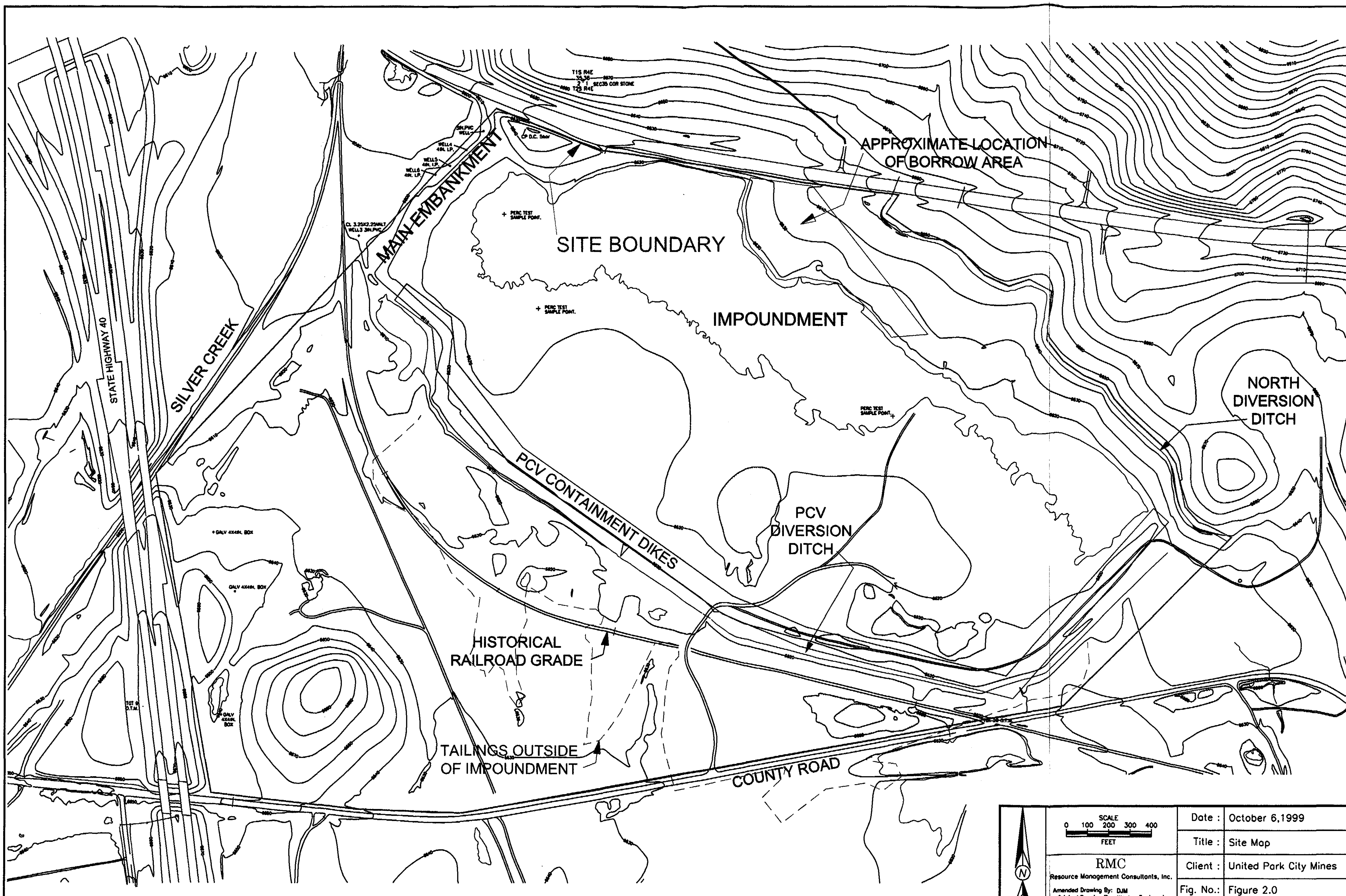
Consistent with the requirements of the NCP, United Park will also prepare a Community Relations Plan ("CRP"). The CRP will address the public notice and comment, including public repository of information, necessary to comply with the NCP. Moreover, if any additional remedial measures are required to support final Site closure, appropriate public notice, together with an opportunity for public comment on any planned remedial measures, will be provided as required by CERCLA and the NCP.

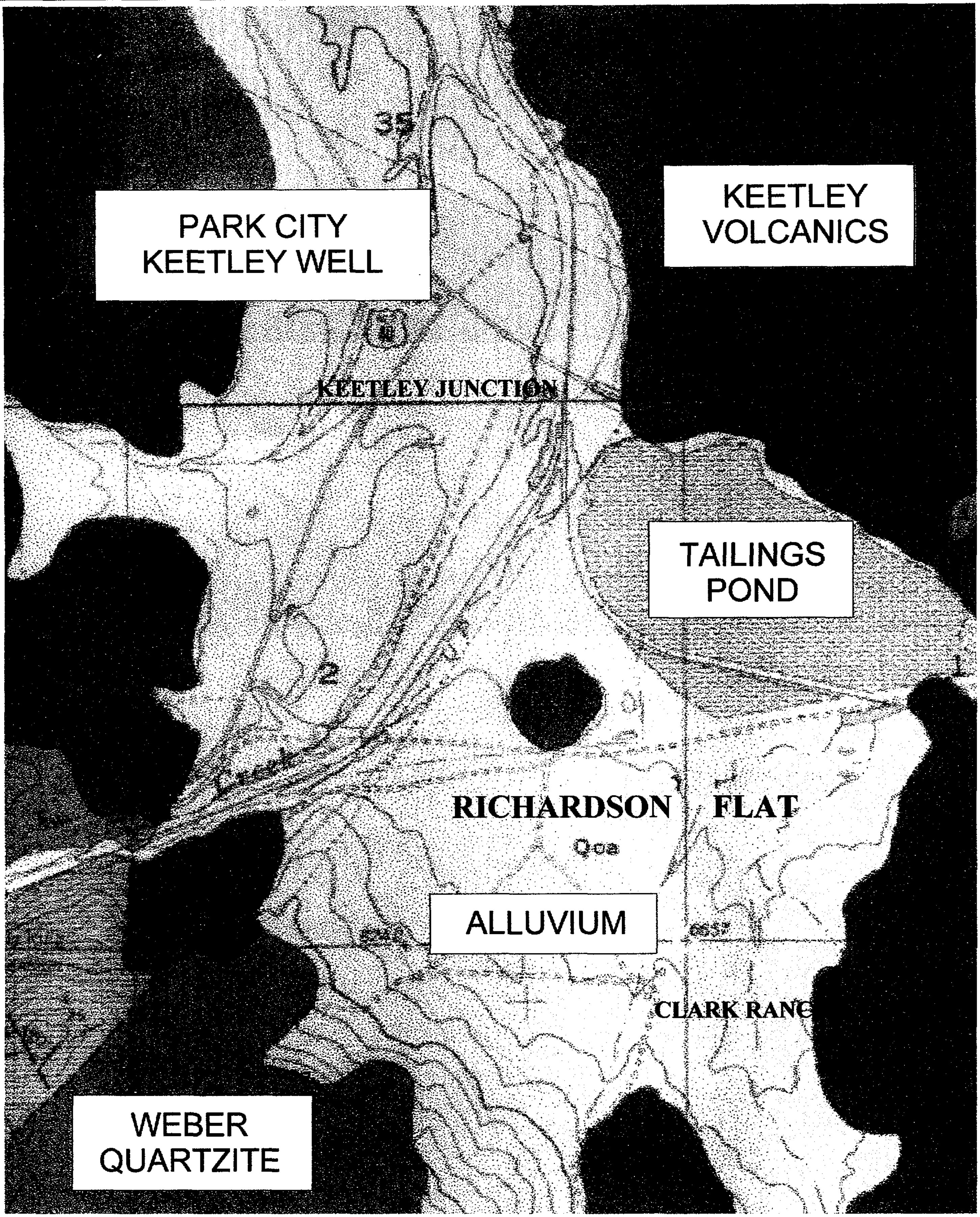
FIGURES

Color Chart(s)

The following charts contain color that does not appear in the scanned images.
To view the actual images please contact the Superfund Record Center at (303) 312-6473.


Snyderville
Round Valley
Homer Spring
Quarry Mtn
Keetley Junction
Old Highway 40
Silver Creek
Tailings Pond
Richardson Flat
Dority Spring
McLeod
Snow Summit Ranch
Clark Ranch
Tailings Pond
Iron Mtn
White Pine Lake
Park City
Masonic Hill
Deer Valley
Deer Valley Meadow
Treasure Hill
Silver King Consolidated
West Monitor Flat
Keetley
Approximate Scale
1000' 0' 1000' 2000'
RMC
Resource Management Consultants, Inc.
Drawn By: PTS
Date : June 10, 1999
Title : Site Location Map
Client : United Park City Mines
Fig. No. : Figure 1.0

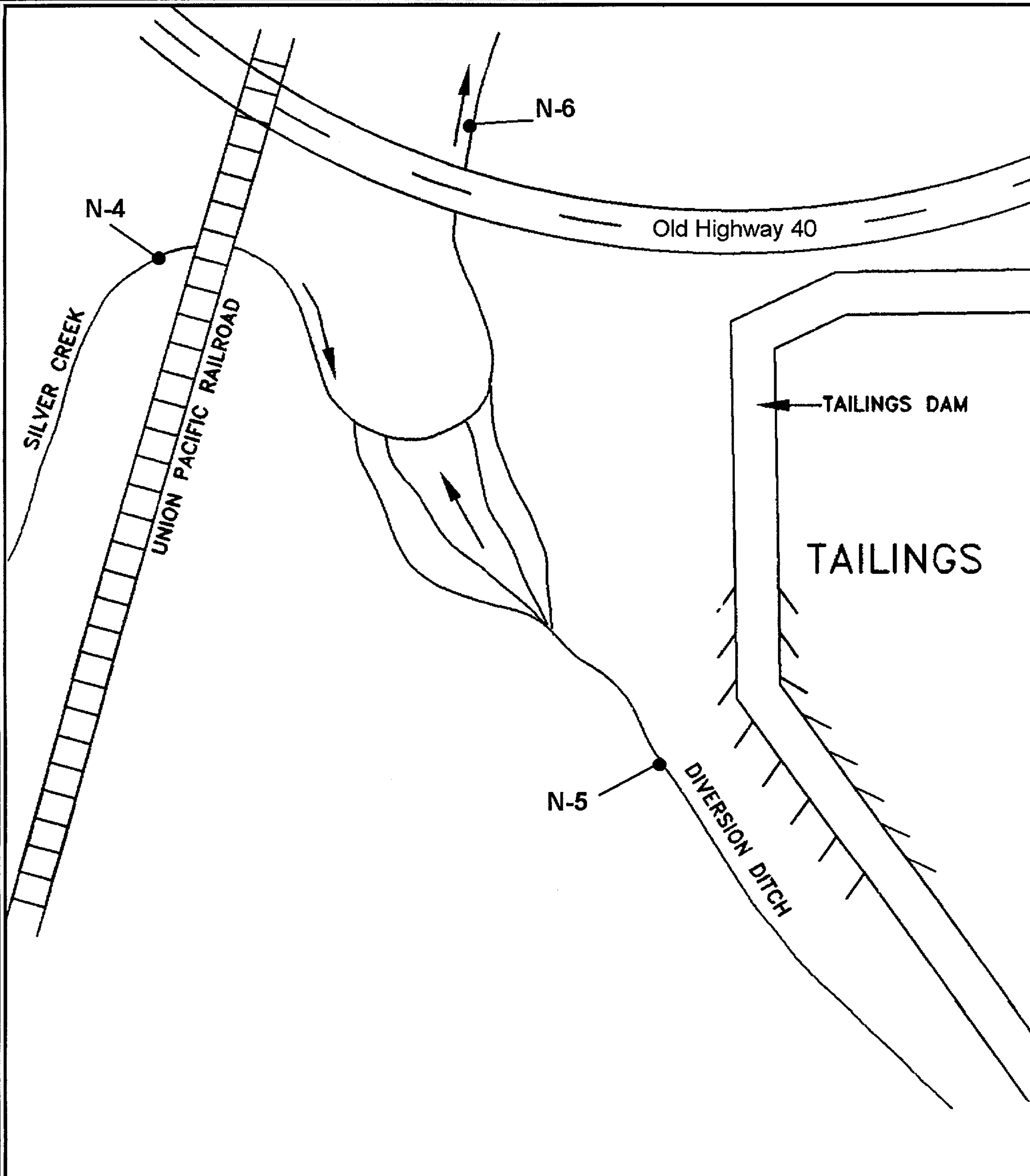

APPROXIMATE LOCATION OF BORROW AREA
SITE BOUNDARY
MAIN EMBANKMENT
IMPOUNDMENT
STATE HIGHWAY 40
SILVER CREEK
NORTH DIVERSION DITCH
PCV CONTAINMENT DIKES
PCV DIVERSION DITCH
HISTORICAL RAILROAD GRADE
TAILINGS OUTSIDE OF IMPOUNDMENT
COUNTY ROAD
SCALE
0 100 200 300 400
FEET
RMC
Resource Management Consultants, Inc.
Amended Drawing By: DJM
Original Drawing By: Weston Engineering
Date : October 6,1999
Title : Site Map
Client : United Park City Mines
Fig. No.: Figure 2.0



DRAFT

* Figure as amended from Bromfield and Crittendon, 1971

N	**RMC** Resource Management Consultants, Inc.	Date :	June 21, 1999
		Title :	RF Geology
		Client :	United Park City Mines
		Fig. No. :	FIGURE 2.1



DRAFT

Surface Water Sample Stations

N-4 - Silver Creek Upstream
N-5 - Diversion Ditch
N-6 - Silver Creek Downstream

Approximate Scale
100' 50' 0' 100'

RMC
Resource Management Consultants, Inc.
Drawn By: PTS
Original Drawing By: Weston Engineering

Date :	June 10, 1999
Title :	Historic Sample Loc.
Client :	United Park City Mines
Fig. No. :	FIGURE 3.1

FIGURE 3.2
Richardson Flat Surface Water
Zinc (T) ppm

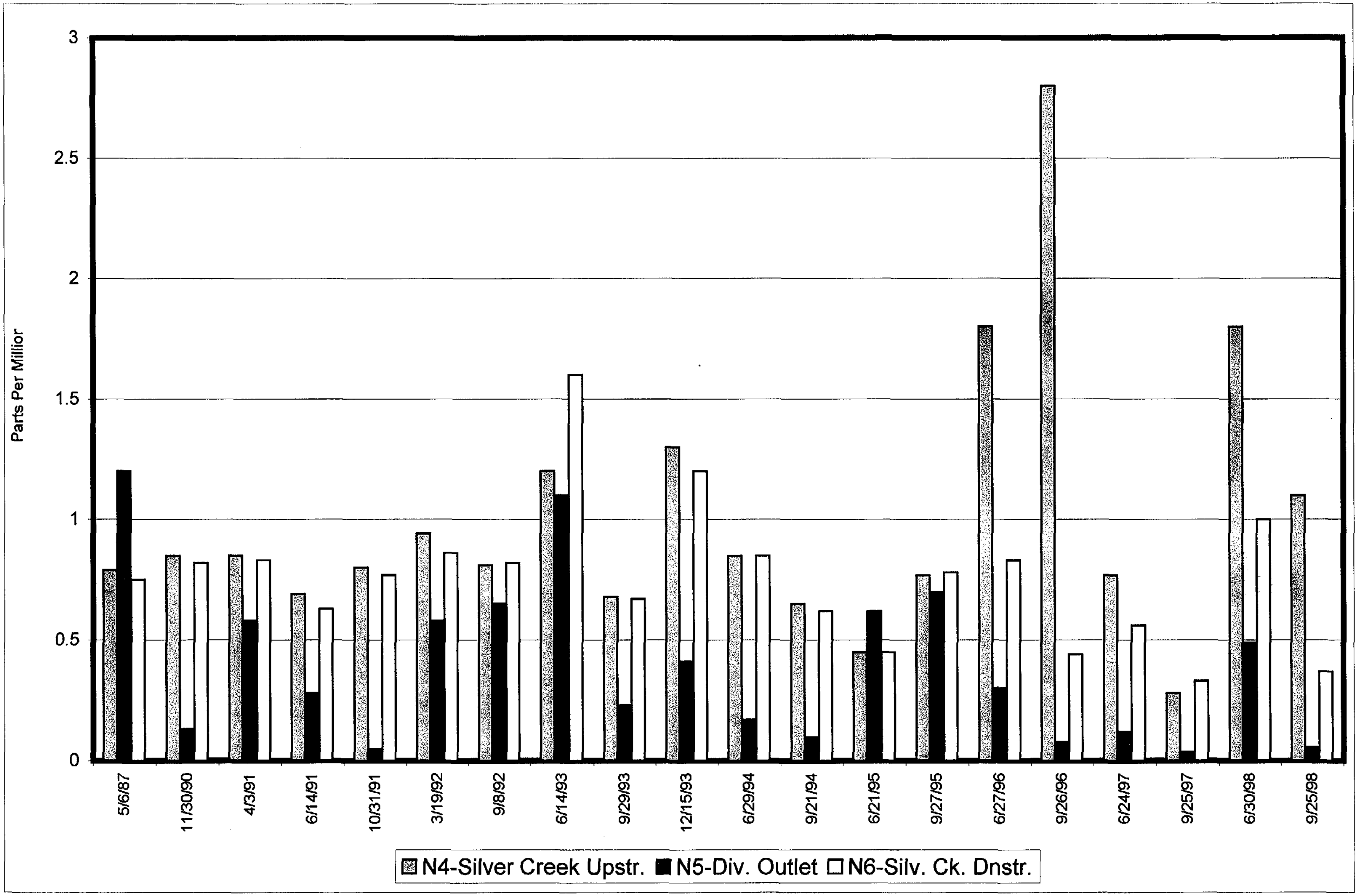
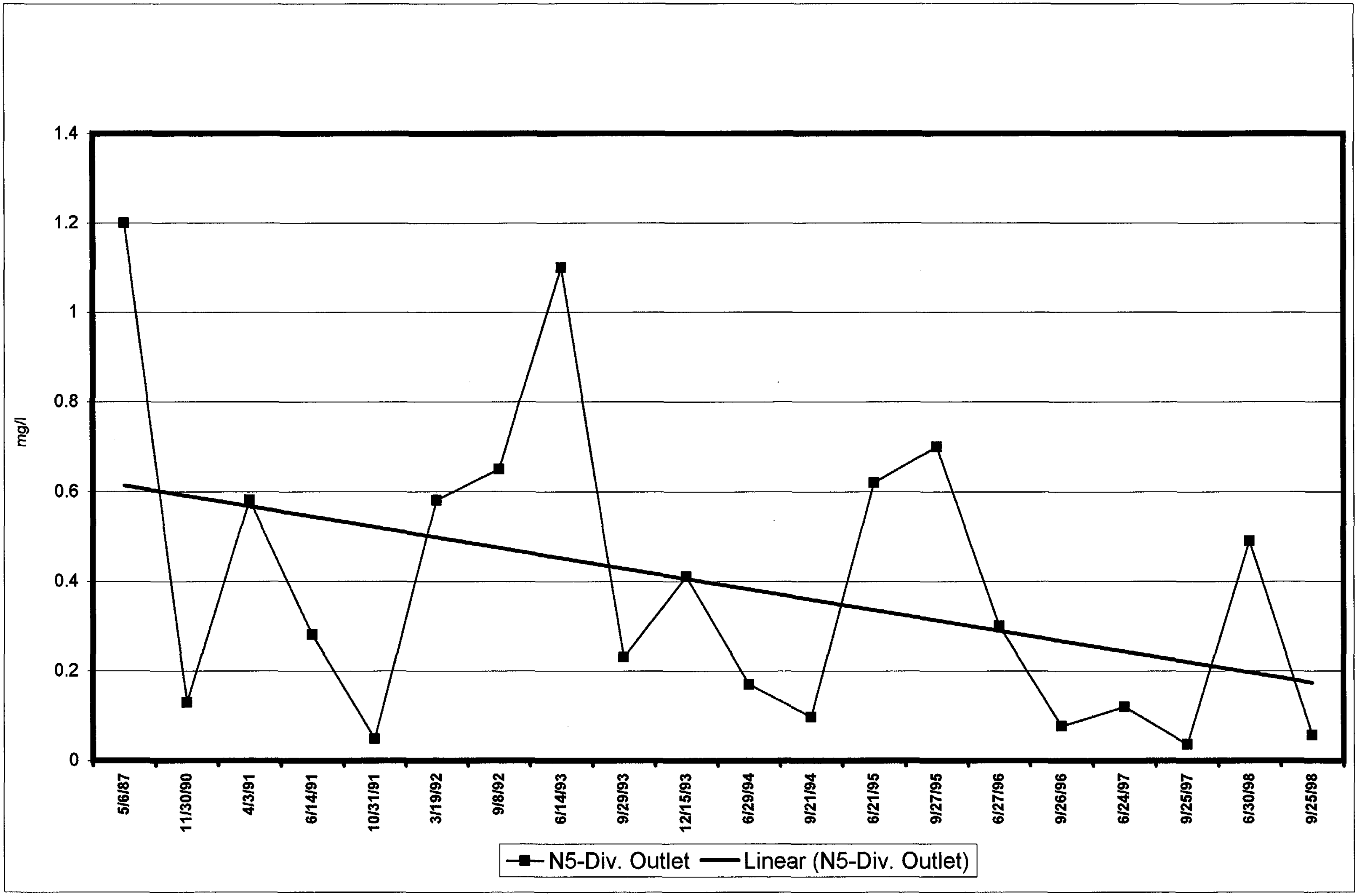
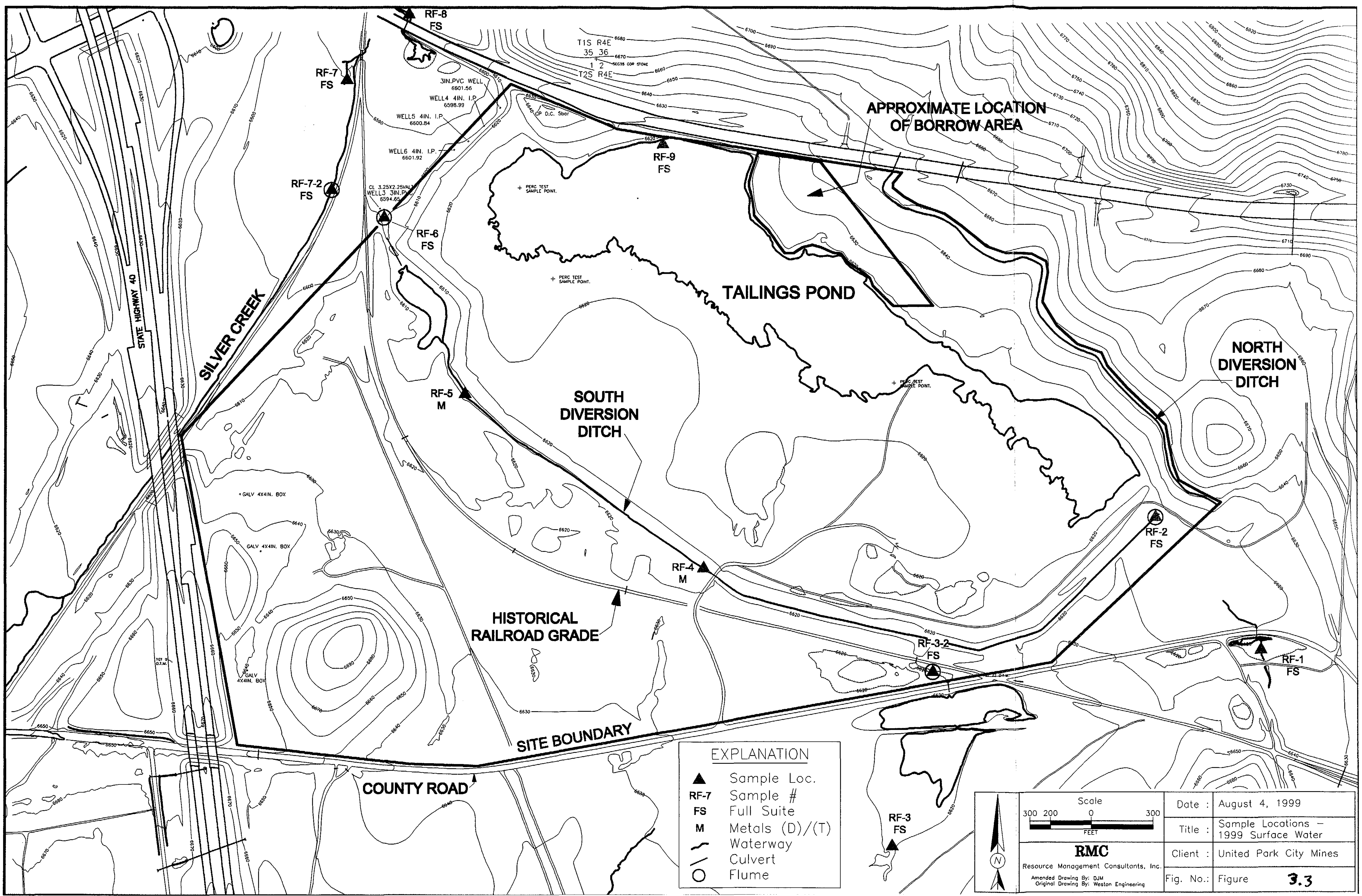


FIGURE 3.2a

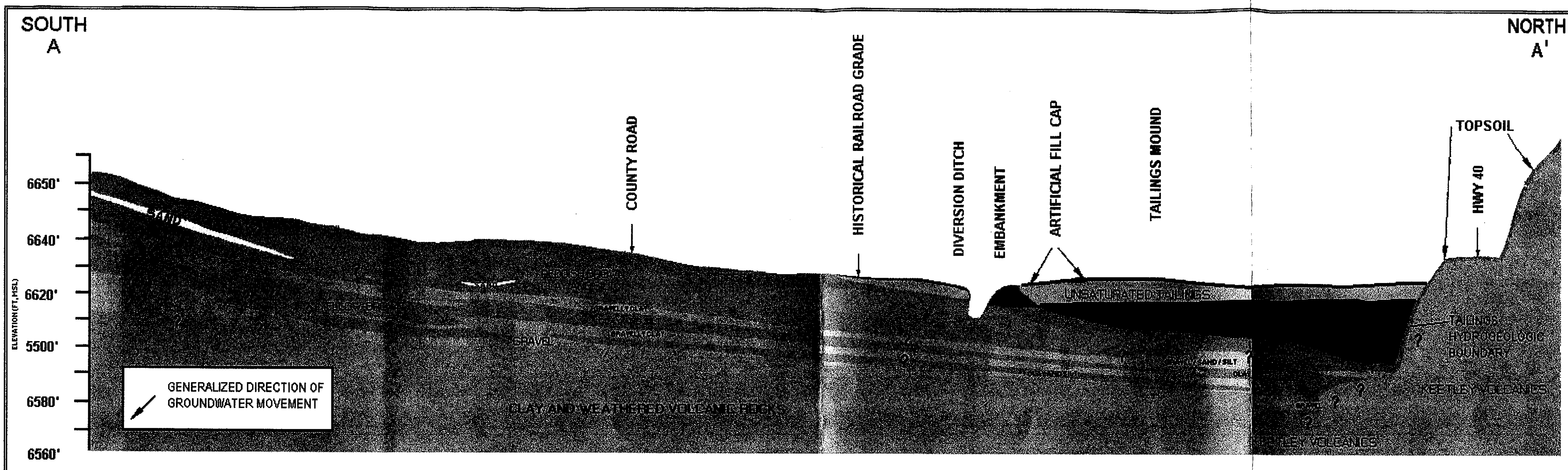
Richardson Flat Surface Water - Diversion Ditch Outlet - Station N5

Zinc (T) mg/l

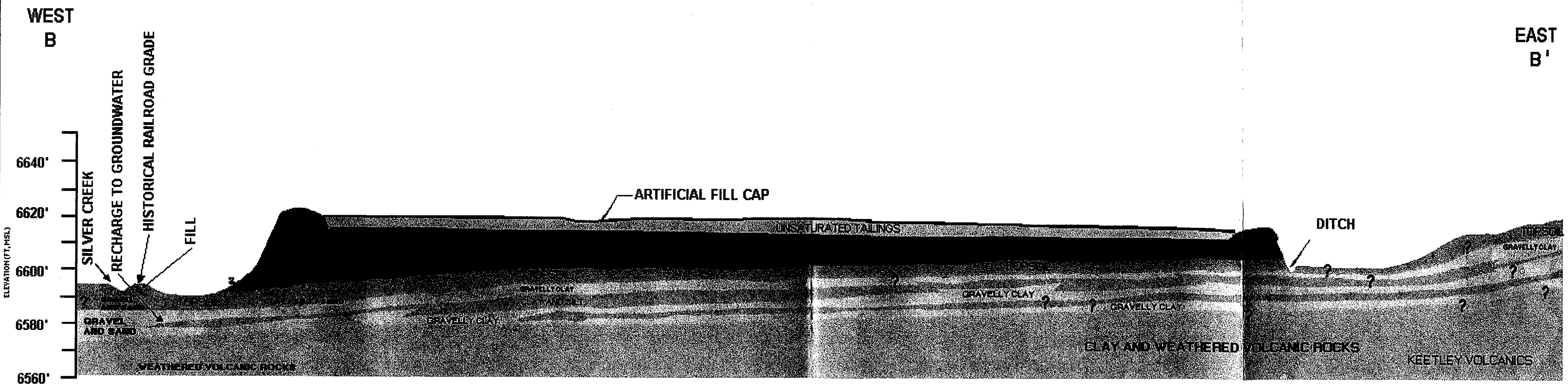




RF-8
FS
RF-7
FS
RF-7-2
FS
RF-6
FS
RF-9
FS
RF-5
M
RF-4
M
RF-3-2
FS
RF-2
FS
RF-1
FS
RF-3
FS
T1S R4E
35 36
1 2
T2S R4E
3IN.PVC WELL
6601.56
WELL4 4IN. I.P.
6598.99
WELL5 4IN. I.P.
6600.84
WELL6 4IN. I.P.
6601.92
APPROXIMATE LOCATION OF BORROW AREA
TAILINGS POND
NORTH DIVERSION DITCH
SOUTH DIVERSION DITCH
SILVER CREEK
STATE HIGHWAY 40
HISTORICAL RAILROAD GRADE
SITE BOUNDARY
COUNTY ROAD
GALV 4X4IN. BOX
EXPLANATION
Sample Loc.
RF-7 Sample #
FS Full Suite
M Metals (D)/(T)
Waterway
Culvert
Flume
Scale
300 200 0 300
FEET
RMC
Resource Management Consultants, Inc.
Amended Drawing By: DJM
Original Drawing By: Weston Engineering
Date : August 4, 1999
Title : Sample Locations – 1999 Surface Water
Client : United Park City Mines
Fig. No.: Figure 3.3



NORTH-SOUTH CONCEPTUAL SITE MODEL CROSS SECTION

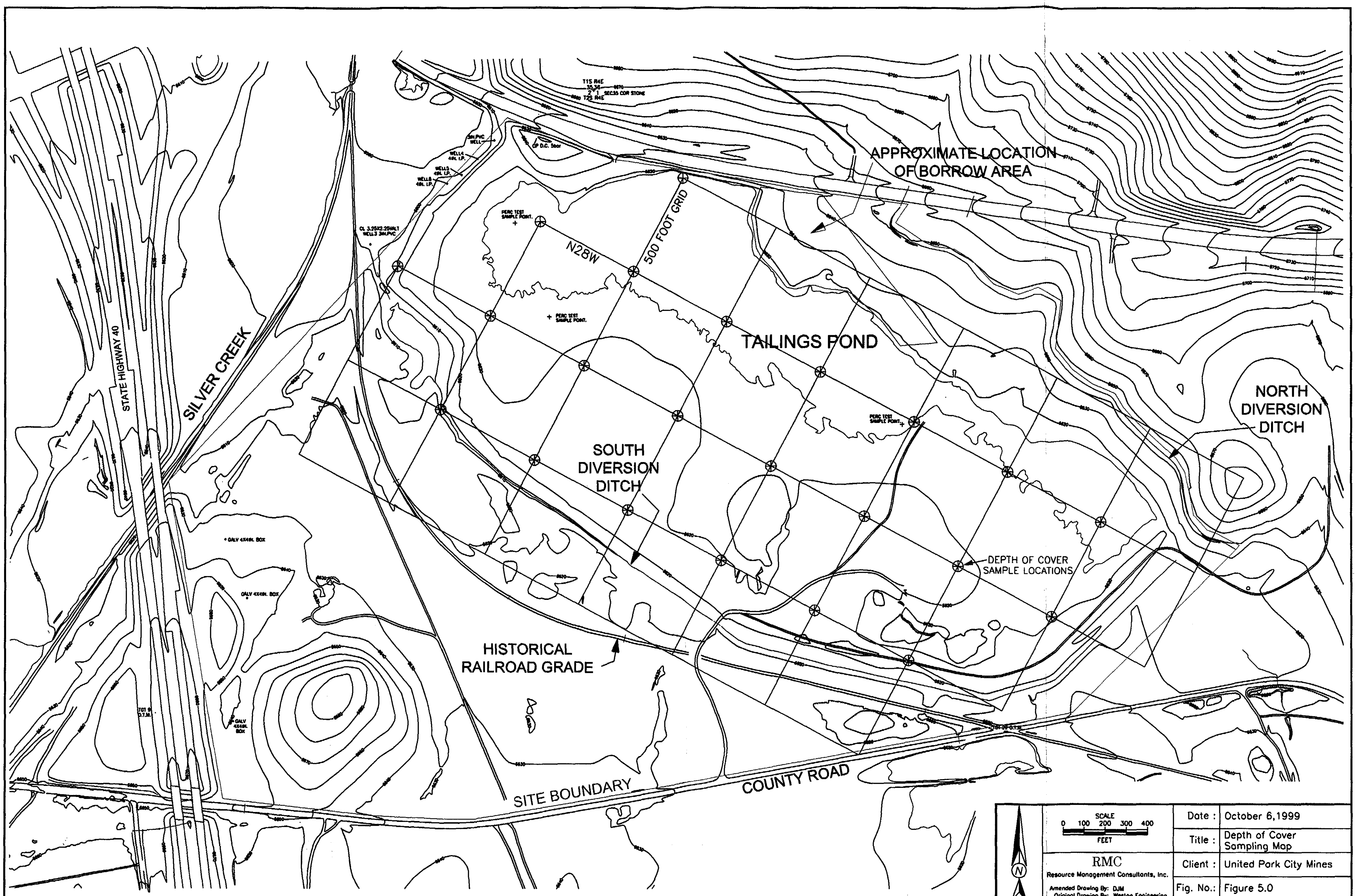


EAST-WEST CONCEPTUAL SITE MODEL CROSS SECTION

DRAFT

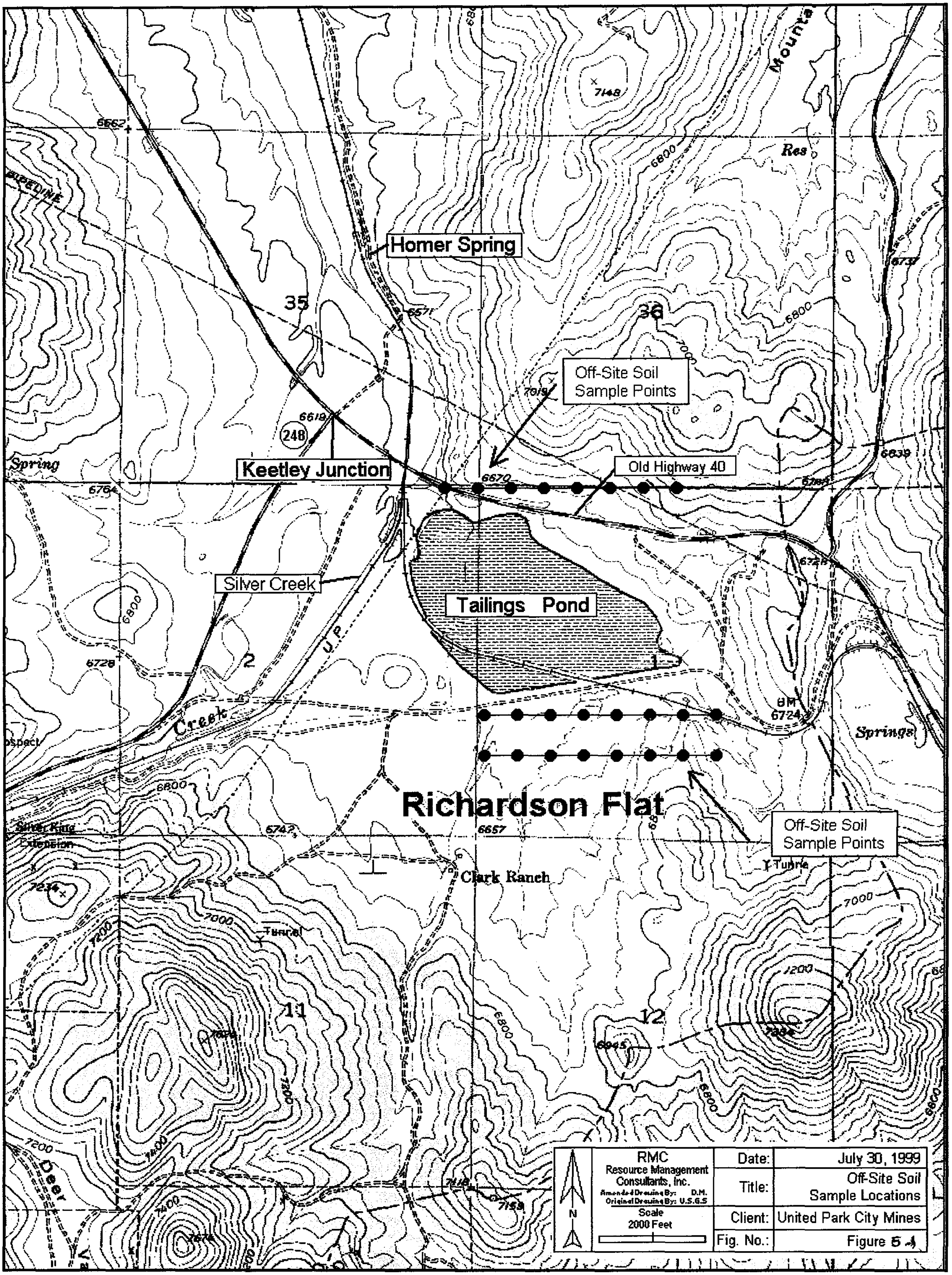
See Figure 2.0 for cross-section locations

RMC Resource Management Consultants, Inc.		Date :	June 10, 1999
		Title :	Conceptual Site Model
Amended Drawing By: Original Drawing By:	PTS Weston Engineering	Client :	United Park City Mines
		Fig. No. :	FIGURE 4.0



RMC
Resource Management Consultants, Inc.
Amended Drawing By: DJM
Original Drawing By: Weston Engineering

Date :	October 6,1999
Title :	Depth of Cover Sampling Map
Client :	United Park City Mines
Fig. No.:	Figure 5.0



Homer Spring
Off-Site Soil Sample Points
Keetley Junction
Old Highway 40
Silver Creek
Tailings Pond
Richardson Flat
Off-Site Soil Sample Points
Clark Ranch
Spring
Springs
Res
PIPELINE
Creek
U.P.
Silver King Extension
Tunnel
Deer
35
36
2
1
11
12
248
RMC
Resource Management Consultants, Inc.
Scale
2000 Feet
N
Date:
July 30, 1999
Title:
Off-Site Soil Sample Locations
Client:
United Park City Mines
Fig. No.:
Figure 5-1

TABLES

Table 3.2: Richardson Flat Groundwater Results (continued)
1982 to 1987 and 1991 to 1998

All units are in mg/l except pH (standard units).

Station MW-1

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Mn	0.073	0.18	0.05	0.13	0.17	0.96	0.45	0.57	0.17	0.083	0.3	0.25	0.35	0.32	0.1
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.03	0.025	0.042	0.067	0.05	0.042	0.02	0.067	0.067	0.05	0.033	0.067	0.067	0.05	0.067
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1193	1262	1208	1223	1243	1187	1189	1210	1201	1412	1349	1344	1431	1297	1334
Cn	<0.004	<0.004	0.004	0.004	0.004	0.006	0.008	0.012	<0.004	0.28	0.008	0.01	0.007	0.007	0.006

Date	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Mn	0.35	0.37	0.42	0.9	0.53	0.88	-	-	0.4	0.27	0.53	0.52	0.68	0.57	0.57
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.05	0.05	0.083	0.083	0.05	0.067	-	-	0.05	0.07	0.07	0.03	0.07	0.08	0.07
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1322	1471	1516	1359	1344	1281	-	-	1274	1216	1435	1429	1310	1268	1238
Cn	0.067	0.025	0.016	0.036	0.017	0.024	-	-	0.035	0.03	0.032	0.032	0.021	0.027	0.027

Station MW-3

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	0.95	0.37	2.1	3.2	3.6	0.63	1.9	3.3	2.1	3.8	3.4	0.42	1.8	0.87	2.6
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.02	0.017	0.05	0.067	0.05	0.05	0.02	0.067	0.05	0.05	0.067	0.05	0.083	0.067	0.067
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1174	1166	1551	1484	1475	1342	1339	1173	1109	1524	1676	1576	1722	1401	1189
Cn	<0.004	<0.004	<0.004	0.004	0.005	0.004	0.006	0.006	<0.004	0.005	0.004	<0.004	<0.004	<0.004	0.004

Date	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.0005	<0.0005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	4.2	3.8	3.4	1.5	1.2	3.8	6.6	5.7	0.9	4.4	3.3	2.6	2.8	3	2.6
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.07	0.067	0.05	0.05	0.067	0.12	0.12	0.1	0.05	0.05	0.07	0.05	0.08	0.08	0.08
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1879	2168	2164	1682	1540	1625	1871	2335	2148	1928	2056	1876	1630	1492	1265
Cn	0.025	0.022	0.006	0.02	0.01	0.016	0.008	0.004	0.0004	<0.004	0.009	0.016	<0.004	0.013	0.01

Station MW-4

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0007	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	12	9.3	12	12	7.5	10	7.5	8.6	-	9.7	11	8	10	8.8	8
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.05	0.067	0.067	0.13	0.067	0.067	0.02	0.1	-	0.067	0.067	0.1	0.099	0.1	0.1
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	2482	2532	2651	2659	2662	2583	2518	2194	-	2569	2693	2648	2713	2660	2183
Cn	0.12	1.2	1.6	1.2	0.91	2.2	2.9	2.3	-	0.006	2.1	1.4	1.5	1.4	0.73

Date	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
Mn	9.2	8.3	10	9.8	5.9	4.5	-	-	3.2	6.1	7.7	8.3	3.3	2	-
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.18	0.2	0.4	0.12	0.067	0.13	-	-	0.18	0.1	0.07	0.07	0.12	0.12	-
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	2667	2666	2525	2685	2120	1893	-	-	2908	2232	2800	2879	2230	1019	-
Cn	4.7	1.6	2.1	8.4	1.6	1.7	-	-	1.2	2.5	3.7	2.5	2.2	0.056	-

Station MW-5

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	14	10	11	13	9.2	15	11	14	8	12	16	13	13	12	9.3
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.05	0.05	0.067	0.067	0.067	0.083	0.02	0.1	0.067	0.13	0.1	0.1	0.23	0.1	0.1
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	2188	2220	2635	2667	2401	2436	2333	2546	2349	2697	2840	3039	2746	2781	2324
Cn	<0.004	<0.004	0.006	0.005	0.008	0.011	0.015	0.007	<0.004	0.35	0.008	<0.004	<0.004	0.005	0.005

Date	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-
Mn	12	8.3	10	9.2	3.2	0.27	-	2	9.3	7.8	10	8.3	2.7	0.27	-
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.1	0.12	0.43	0.17	0.033	0.05	-	0.05	0.17	0.2	0.22	0.15	0.13	0.12	-
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	2836	2506	2261	3844	684	73	-	1450	3032	2315	1197	2101	883	96	-
Cn	0.024	0.03	<0.004	0.2	0.01	<0.004	-	<0.004	0.006	0	0.01	0.006	<0.004	<0.004	-

Station MW-6

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-86	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	0.0005	<0.005	<0.005	<0.005	<0.005	0.0005	<0.005	<0.005
Mn	2.7	2.8	2.4	2.4	2.4	2.9	3.7	4	4.2	3.1	3.2	3.5	4	3.8	2.8
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.02	0.033	0.05	0.033	0.033	0.067	<0.020	0.1	0.05	0.05	0.067	0.13	0.13	0.067	0.067
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1526	1212	1298	1319	1314	1310	1304	1458	1281	1446	1417	1520	1510	1597	1060
Cn	0.006	0.19	0.25	0.086	0.29	0.98	0.92	0.019	0.92	0.008	0.55	0.31	0.53	0.26	0.22

Date	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005
Mn	3.2	2.7	2.9	3.7	3.7	1.7	-	-	2.5	1.7	3.7	3	-	2.1	1.1
Mn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Pb	0.07	0.05	0.13	0.083	0.05	0.05	-	-	0.03	0.08	0.15	0.12	-	0.27	0.28
Pb-D, TR	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
pH	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1422	1288	1322	2201	1260	644	-	-	1433	936	2973	1141	-	972	1725
Cn	0.018	0.51	0.52	4.6	0.08	0.032	-	-	0.74	0.026	0.06	0.054	-	<0.004	0.01

** Value exceeds Utah GW Quality Standard
Refer to Plate 1, Weston Report, Appendix A for well locations

Table 3.3: Comparison of 1985, 1992, and 1998 Groundwater Data

All units are in mg/l except pH (standard units).

Location: Well RT-1				
Date	**September, 1985** [1]		**August, 1992** [1]	
Sample ID	RF-GW-1		RF-GW-04	
	Total	Dissolved	Total	Dissolved
Aluminum	1.04	<0.03	15.7	0.191
Antimony	<0.005	<0.005	0.02436	0.0332
Arsenic	<0.005	<0.005	0.0037	0.0036
Barium	0.083	0.076	0.196	0.0939
Beryllium	<0.01	<0.01	0.0013	0.0009
Cadmium	<0.005	<0.005	0.0033	0.0033
Calcium	0.045	0.047	42.2	43.5
Chromium	<0.005	<0.005	0.0105	0.0078
Cobalt	<0.005	<0.005	0.011	0.006
Copper	<0.005	<0.005	0.03	0.171
Iron	0.955	<0.01	14.1	0.151
Lead	<0.03	<0.03	0.627	0.0409
Magnesium	0.909	0.908	12.2	0.0088
Manganese	0.02	0.011	0.162	0.0195
Mercury	<0.0001	<0.0001	0.0002	0.0002
Nickel	<0.03	<0.03	0.013	0.0111
pH	-	-	-	-
Potassium	-	-	1.39	1.36
Selenium	<0.005	<0.005	0.003	0.003
Silver	<0.005	<0.005	0.0024	0.01
Sodium	0.016	0.016	16.1	16.8
TDS	-	-	-	-
Thalluim	<0.1	<0.1	0.0016	0.0016
Tin	-	-	-	-
Vanadium	<0.01	<0.01	0.0357	0.0357
Zinc	<0.005	0.006	0.136	0.0201
Cyanide	<0.01	-	-	-
Sulfate	0.035	-	-	-

Location: Well MW-1						
Date	**September, 1985** [1]		**August, 1992** [1]		**September, 1998** [2]	
Sample ID	RF-GW-3		RF-GW-05		MW-1	
	Total	Dissolved	Total	Dissolved	Total	Dissolved
Aluminum	80.7	<0.03	2.69	0.0496	-	-
Antimony	<0.005	<0.005	0.0243	0.0405	-	-
Arsenic	0.076	<0.005	0.0052	0.0036	-	-
Barium	1.534	0.104	0.0996	0.064	-	-
Beryllium	-	<0.01	0.0034	0.0018	-	-
Cadmium	0.042	<0.005	0.0033	0.0033	-	-
Calcium	0.352	0.254	191	196	-	-
Chromium	0.095	<0.005	0.0078	0.0078	-	-
Cobalt	0.046	0.01	0.0075	0.006	-	-
Copper	1.583	<0.005	0.03	0.02	<0.008	-
Iron	126	0.376	3.18	0.0626	-	-
Lead	0.588	<0.03	0.0156	0.0022	-	<0.01
Magnesium	0.088	0.056	44.2	41.8	-	-
Manganese	2.23	0.924	0.89	0.684	-	10
Mercury	0.0007	<0.0001	0.0002	0.0002	<0.0002	-
Nickel	0.088	<0.03	0.0111	0.0249	-	-
pH	-	-	-	-	7.2	-
Potassium	-	-	6.06	5.53	-	-
Selenium	<0.005	<0.005	0.015	0.015	-	-
Silver	<0.005	<0.005	0.0024	0.01	-	-
Sodium	0.044	0.042	38.1	35.7	-	-
TDS	-	-	-	-		730
Thalluim	<0.1	<0.1	0.0016	0.0016	-	-
Tin	-	-	-	-	-	-
Vanadium	0.262	<0.01	0.0357	0.0357	-	-
Zinc	0.65	<0.005	0.0995	0.0144	-	0.038
Cyanide	<0.1	-	-	-	-	-
Sulfate	0.625	-	-	-	-	-

Location: Well MW-6						
Date	**September, 1985** [1]		**August, 1992** [1]		**September, 1998** [2]	
Sample ID	RF-GW-2		RF-GW-09		MW-6	
	Total	Dissolved	Total	Dissolved	Total	Dissolved
Aluminum	4.92	<0.03	1.63	0.0685	-	-
Antimony	0.063	<0.005	0.0284	0.0359	-	-
Arsenic	0.349	0.009	0.0113	0.0088	-	-
Barium	2.665	0.099	0.0583	0.0462	-	-
Beryllium	<0.01	<0.01	0.0049	0.0037	-	-
Cadmium	0.016	<0.005	0.0033	0.0033	-	-
Calcium	0.314	0.307	318	365	-	-
Chromium	0.042	<0.005	0.0078	0.0078	-	-
Cobalt	0.08	0.067	0.009	0.006	-	-
Copper	0.19	<0.005	0.02	0.02	<0.008	-
Iron	26.3	14.8	3.19	2.17	-	-
Lead	1.08	<0.03	0.031	0.0022	-	<0.01
Magnesium	0.072	0.07	52.5	55	-	-
Manganese	10.4	9.99	6.67	7.42	-	9.4
Mercury	0.0001	<0.0001	0.0002	0.0002	-	<0.0002
Nickel	0.03	<0.03	0.0256	0.0289	-	-
pH	-	-	-	-	7.1	-
Potassium	-	-	3.29	3.01	-	-
Selenium	<0.005	<0.005	0.015	0.015	-	-
Silver	0.017	<0.005	0.0033	0.01	-	-
Sodium	0.054	0.052	0.486	49.7	-	-
TDS	-	-	-	-	-	1354
Thalluim	<0.1	<0.1	0.0016	0.0016	-	-
Tin	-	-	-	-	-	-
Vanadium	0.017	<0.01	0.0357	0.0357	-	-
Zinc	2.79	0.144	0.0925	0.0131	-	0.061
Cyanide	0.2	-	-	-	-	-
Sulfate	0.775	-	-	-	-	-

[1] Data collected by EPA contractor, E&E in 1984 and 1992

[2] Data collected by United Park

Table 3.1:Richardson Flats Surface Water Results, 1982 to 1987 and 1990 to 1998

All units are in mg/l.

Station N4 - Upstream Silver Creek

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	30-Nov-90	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	5-Nov-86	10-Oct-86	3-Sep-86	10-Aug-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	0.043	0.27	0.012	<.008	0.39	0.038	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.0005	<0.0005	<0.0005	-	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005
Mn-T	0.34	0.58	0.8	1.3	0.5	0.79	0.24	0.18	0.14	0.28	0.24	0.3	0.28	0.55	0.25	0.073	0.16	0.2	0.18	0.33	0.033	0.12	0.16	-	0.36	0.17	0.027	-	0.085	0.038	0.1
Pb-T	1.6	7.5	0.035	0.038	26	2.6	<0.01	0.012	0.033	0.02	0.033	0.033	<0.02	0.15	0.37	0.033	0.079	0.05	<0.02	0.18	0.033	0.02	0.05	0.12	0.05	0.05	0.05	-	0.033	0.02	0.07
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.02	-	-	-	-	-	-	-
Zn-T	1.1	1.8	0.28	0.77	2.8	2.8	0.77	0.45	0.65	0.85	1.3	0.68	1.2	0.81	0.94	0.8	0.69	0.85	0.85	-	-	-	-	0.79	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.56	-	-	-	-	-	-	-
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	<0.004	-	<0.004	0.004	<0.004	-	<0.004	0.007	<0.004
TDS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	730	666	628	720	-	1053	638	642	-	615	604	260
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.8	-	-	-	-	-	-	-

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-85	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	31-Jan-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	0.0005	<0.0005	2	<0.0005	<0.0005	0.9	<0.0005	0.0089	<0.0005	<0.0005	<0.0005	0.0046	<0.0005	0.0008	<0.0005	<0.0005	0.0008	<0.0005	<0.0005	<0.0005	<0.0005	0.0007
Mn-T	0.18	0.27	0.33	0.17	0.1	0.055	0.33	0.083	0.3	0.083	0.1	0.4	0.7	0.37	0.13	0.1	0.67	0.33	0.1	0.28	0.38	0.38	0.33	0.32	0.17	0.38	0.12	0.17	0.17	0.43	0.28
Pb-T	0.03	0.083	0.05	0.12	0.05	0.033	0.05	0.05	0.18	0.067	0.067	0.78	0.067	0.1	0.13	0.05	1.3	0.033	0.05	0.05	0.9	0.02	0.17	0.07	0.05	0.13	0.03	0.03	0.07	0.92	0.35
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cn	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.054	<0.008	<0.004	0.014	<0.004	0.004	0.009	<0.004	<0.004	<0.004	<0.004	0.005	<0.004	<0.004	0.004	<0.004
TDS	648	760	638	583	729	558	648	498	661	552	600	456	1015	684	387	613	586	830	726	496	303	720	659	809	609	538	719	723	554	516	491
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Station N5 - Diversion Ditch

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	30-Nov-90	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	5-Nov-86	10-Oct-86	3-Sep-86	10-Aug-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.013	<0.008	0.008	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn-T	3.4	1.7	1.9	7	7.7	2.1	1.1	1.4	8.7	1.6	8.3	1.7	1.5	61	1.2	0.083	0.42	0.92	3	3.1	1.3	1.6	1.4	-	1.1	0.78	1.8	0.75	0.045	1.2	0.23
Pb-T	<0.01	<0.01	<0.01	<0.01	0.014	<0.01	<0.01	<0.01	0.05	0.033	0.05	0.05	<0.02	<0.1	<0.02	0.033	0.095	0.02	<0.02	0.067	0.02	0.05	0.067	<0.017	0.033	0.067	0.05	0.05	0.05	0.02	<0.017
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.017	-	-	-	-	-	-	-
Zn-T	0.056	0.49	0.036	0.12	0.076	0.3	0.7	0.62	0.097	0.17	0.41	0.23	1.1	0.65	0.58	0.048	0.28	0.58	0.13	-	-	-	-	1.2	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.76	-	-	-	-	-	-	-
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	<0.004	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
TDS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1867	1704	1511	1300	-	1676	1538	1671	1882	1731	1693	1542
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2.4	-	-	-	-	-	-	-

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-85	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	31-Jan-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn-T	0.84	0.58	0.7	1.2	0.6	1.4	1.6	1.7	2	0.95	0.1	0.57	-	0.23	0.48	0.17	0.17	0.48	0.22	0.53	1.4	-	3.2	0.45	9.5	1.4	6	6.1	3	3.1	0.33
Pb-T	0.02	0.033	0.042	0.067	0.067	0.042	0.02	0.05	0.1	0.05	0.067	0.067	-	0.053	0.033	0.05	0.05	0.05	0.05	0.067	0.05	-	0.07	0.05	0.03	0.05	0.08	0.07	0.08	0.08	0.08
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cn	<0.004	<0.004	<0.004	<0.004	<0.004	0.004	<0.004	<0.004	0.014	<0.004	<0.004	<0.004	-	0.004	<0.004	0.007	0.016	<0.004	0.006	<0.004	<0.004	-	<0.004	0.004	<0.004	<0.004	0.007	0.006	0.019	0.034	<0.004
TDS	687	566	1277	1570	1610	1372	1520	1418	870	1166	581	1717	-	1533	655	1419	1809	1867	1762	1604	1010	-	1343	839	1192	881	1979	2016	1640	1517	638
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Station N6 - Downstream Silver Creek

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	30-Nov-90	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	5-Nov-86	10-Oct-86	3-Sep-86	10-Aug-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.009	<0.008	0.011	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005
Mn-T	0.3	0.45	0.2	0.7	0.35	0.36	0.26	0.21	0.16	0.4	0.21	0.25	0.43	0.56	0.21	0.057	0.12	0.22	0.18	0.32	0.11	0.19	0.24	-	0.3	0.23	0.37	-	0.93	0.057	0.11
Pb-T	<0.01	0.05	<0.01	0.033	0.042	0.016	<0.01	0.01	0.033	0.033	0.033	0.05	0.025	0.22	0.043	0.033	0.097	0.08	<0.02	0.13	0.058	0.12	0.12	0.14	0.27	0.083	0.05	-	0.05	0.02	0.04
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.025	-	-	-	-	-	-	-
Zn-T	0.37	1	0.33	0.56	0.44	0.83	0.78	0.45	0.62	0.85	1.2	0.67	1.6	0.82	0.86	0.77	0.63	0.83	0.82	-	-	-	-	0.75	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.37	-	-	-	-	-	-	-
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.005	<0.004	<0.004	-	0.005	<0.004	<0.004	-	<0.004	<0.004	<0.004
TDS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	723	655	915	750	-	866	636	629		656	569	265
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3.7	-	-	-	-	-	-	-

Date	1-May-86	7-Apr-86	4-Nov-85	3-Oct-85	9-Sep-85	2-Aug-85	10-Jul-85	3-Jun-85	1-May-85	1-Nov-84	3-Oct-84	6-Sep-84	10-Aug-84	3-Jul-84	8-Jun-84	1-Nov-83	6-Oct-83	2-Sep-83	2-Aug-83	6-Jul-83	8-Jun-83	31-Jan-83	3-Jan-83	3-Dec-82	1-Nov-82	1-Oct-82	30-Aug-82	2-Aug-82	1-Jul-82	1-Jun-82	29-Apr-82
Cu	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	2.1	<0.005	<0.005	<0.005	<0.005	0.0084	<0.005	<0.005	<0.005	0.0033	-	-	-	<0.005	<0.005	<0.005	<0.005	<0.005	0.0022	<0.005
Mn-T	0.073	0.33	0.35	0.15	0.18	0.23	0.42	0.083	0.21	0.1	0.5	0.35	0.83	0.72	0.12	0.08	0.68	0.42	0.13	0.3	0.32	-	-	-	0.22	0.38	0.2	0.32	0.27	0.48	0.25
Pb-T	<0.02	0.017	0.05	0.05	0.067	0.033	0.03	0.05	0.083	0.067	0.05	0.62	0.067	0.1	0.12	0.07	0.5	0.17	0.05	0.05	0.58	-	-	-	0.05	0.1	0.03	0.05	0.08	1	0.18
Pb-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-T	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Cn	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.008	0.007	0.005	<0.004	<0.004	-	-	-	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
TDS	590	772	664	603	709	648	782	470	652	589	1524	481	1122	684	403	595	580	801	689	476	295	-	-	-	598	552	1506	708	596	330	329
TSS	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Refer to Figure 3.1 for sample locations.

Table 3.2: Richarson Flat Groundwater Results, 1982 to 1987 and 1991 to 1998

All units are in mg/l except pH (standard units).

Station MW-1

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.012	<0.008	0.011	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.0005	<0.0005	<0.0005	-	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005	<0.0005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.067	0.11	0.052	0.47	0.25	0.27	0.14	0.05	0.017	0.092	0.16	0.11
Mn-D	10	8.9	9.1	9.4	8.7	0.65	0.6	0.71	0.65	0.56	0.48	1.1	0.63	33	0.18	0.062	<0.02	0.1	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.067	0.035	0.033	0.083	0.08	0.083	0.033	0.05	0.05	0.04	0.05	0.017
Pb-D, TR	<0.01	<0.01	<0.01	<0.01	<0.01	0.016	<0.01	<0.01	0.033	0.033	0.033	0.033	<0.02	<0.1	<0.02	0.02	0.57	0.02	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	0.038	0.049	0.025	0.12	0.19	0.016	0.027	0.049	0.023	0.01	0.042	0.11	0.041	<.050	0.25	0.018	0.039	0.017	-	-	-	-	-	-	-	-	-	-	-	-
pH	7.2	7.4	6.9	6.9	6.6	7	8	7.3	7.3	7.8	7.1	7.1	6.9	7.7	7.8	7.8	7.6	7.7	-	-	-	-	-	-	-	-	-	-	-	-
TDS	730	1575	2044	1836	1919	1212	1124	1101	1093	1083	1082	1068	596	1732	901	826	750	842	841	919	843	1100	1041	1143	1433	1163	1216	1182	1169	1171
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	0.006	<0.004	<0.004	<0.004	0.008	<0.004	<0.004	0.013	<0.004

Station MW-3

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.012	<0.008	0.008	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6.2	4.8	5.4	5	4.2	4.5	2.9	1.7	4	2.5	0.95	2.8
Mn-D	0.85	0.76	0.75	0.78	0.72	7.7	6	4.6	6.6	4.7	7.3	6.4	5	-	3.8	3.7	2.2	2.1	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.05	0.02	0.083	0.1	0.053	0.067	0.033	0.067	0.033	0.05	0.033	0.03
Pb-D, TR	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.025	0.05	0.05	0.05	0.033	<0.02	-	0.02	0.02	0.062	0.03	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	0.034	0.034	0.035	0.03	0.017	0.017	0.033	0.037	0.054	0.023	0.047	0.11	0.033	-	0.17	0.047	0.065	0.08	-	-	-	-	-	-	-	-	-	-	-	-
pH	7.2	7.4	6.8	6.9	6.7	6.9	8	7.3	7.2	7.9	7.1	7.2	7.1	-	7.7	7.9	7.7	7.7	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1736	1153	1335	1344	1145	1610	1588	1071	1775	1445	1629	1600	741	-	1479	1711	14321	1681	1639	1490	1374	1500	1458	1622	2046	1755	1539	1516	1438	1338
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	0.005	0.005	0.004	<0.004	<0.004	<0.004	0.007	0.004	0.006

Station MW-4

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	0.009	<0.008	0.014	0.008	0.015	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	9.8	11	12	11	6.2	0.23	11	9.4	7.5	8.4	9.4	11
Mn-D	7.2	2.2	6.9	2.1	2	3	4.1	5.7	4.3	3.1	3.6	4.8	7.7	-	7.4	4.7	11	7.7	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.067	0.035	0.05	0.083	0.017	0.05	0.067	0.083	0.067	0.067	0.17	0.017
Pb-D, TR	<0.01	0.018	0.018	0.046	0.033	0.016	<0.01	<0.01	0.05	0.05	0.033	0.033	<0.02	-	<0.02	<0.02	0.11	0.05	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	0.066	0.11	0.044	0.064	0.035	0.095	0.066	0.034	0.03	0.058	0.12	0.12	0.47	-	0.28	0.35	0.12	0.05	-	-	-	-	-	-	-	-	-	-	-	-
pH	2.7**	7.4	7.3	6.7	6.6	7	7.3	6.4**	7.2	7.2	7	6.9	6.8	-	3.1**	7.8	5.6**	5**	-	-	-	-	-	-	-	-	-	-	-	-
TDS	819	1783	2150	1848	1543	1879	2448	2591	1896	2260	2168	2175	2690	-	1911	2289	2190	2348	2583	2593	2556	2700	1902	689	2913	2531	2553	2563	1609	2559
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.28	0.4	0.41	0.96	0.78	0.004	1.1	0.9	99	0.9	0.96	1

Station MW-5

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	0.009	<0.008	0.014	<0.008	0.015	<0.008	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	14	15	16	16	14	1.6	13	12	12	14	15	15
Mn-D	15	9.1	5.8	9.6	9.7	7.3	2	1.9	1.9	0.7	3.2	3	8.5	-	8.4	6.7	15	10	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.15	0.033	0.067	0.12	0.12	0.067	0.083	0.083	0.067	0.067	0.067	0.017
Pb-D, TR	0.015	0.018	0.031	0.047	0.027	<0.01	<0.01	<0.01	0.033	<0.02	0.033	0.05	<0.02	-	<0.02	0.05	0.14	0.03	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	1.9	1	0.27	1	1.9	0.64	0.052	<.008	0.057	0.029	0.22	0.21	1.2	-	0.21	0.75	0.084	0.067	-	-	-	-	-	-	-	-	-	-	-	-
pH	4.1**	7.7	7.2	6.7	6.6	7	6.5	6.6	6.9	6.8	6.5	6.3**	6.9	-	6.7	3.9**	5**	5.5**	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1900	2006	1926	2087	1849	1715	1810	1794	1287	1000	1751	1714	1114	-	651	2026	2225	2344	2435	2460	2318	2400	2509	1989	3102	2464	2498	2467	2465	2407
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	<0.004	<0.004	<0.004	0.006	0.005	<0.004	<0.004	0.005	0.006	0.005	0.004	0.005

Station MW-6

Date	25-Sep-98	30-Jun-98	25-Sep-97	24-Jun-97	26-Sep-96	27-Jun-96	27-Sep-95	21-Jun-95	21-Sep-94	29-Jun-94	15-Dec-93	29-Sep-93	14-Jun-93	8-Sep-92	19-Mar-92	31-Oct-91	14-Jun-91	3-Apr-91	9-Sep-87	3-Aug-87	7-Jul-87	5-Jun-87	6-May-87	2-Dec-86	5-Nov-86	10-Oct-86	3-Sep-86	1-Aug-86	1-Jul-86	5-Jun-86
Cu	<0.008	<0.008	0.038	0.008	<0.008	<0.08	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Hg	<0.0002	<0.0002	<0.0005	<0.0005	<0.0005	<0.0005	-	-	-	-	-	-	-	-	-	-	-	-	<0.005	<0.005	<0.005	-	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005
Mn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1.9	1.3	1.7	2	2.5	0.13	1.8	1.9	1.7	2	2.5	2.8
Mn-D	9.4	1.1	1.1	1.2	0.93	0.64	2.2	1.2	1.1	0.92	1.3	1.1	0.49	7	1.3	2.2	1.1	2.5	-	-	-	-	-	-	-	-	-	-	-	-
Pb	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.033	0.02	0.033	0.05	<.017	0.12	0.067	0.083	0.067	0.083	0.067	0.023
Pb-D, TR	<0.01	<0.01	<0.01	0.027	<0.01	<0.01	<0.01	<0.01	0.05	<0.02	0.05	0.033	<0.02	<0.1	<0.02	0.033	0.056	<0.02	-	-	-	-	-	-	-	-	-	-	-	-
Zn-D	0.061	0.036	0.039	0.019	0.043	0.052	0.029	<0.008	0.013	0.018	0.035	0.07	0.017	<0.05	0.21	0.03	0.017	0.017	-	-	-	-	-	-	-	-	-	-	-	-
pH	7.1	8.2	7.1	7.1	7	7.2	7.4	6.9	7	7.4	7	7	6.6	7.8	6.7	7.4	7.1	7	-	-	-	-	-	-	-	-	-	-	-	-
TDS	1354	1076	1225	687	1150	954	641	685	587	582	529	576	172	1131	651	1516	893	630	974	1226	1135	2460	1130	680	1588	1354	1402	1399	1489	1463
Cn	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	0.022	-	0.18	<0.004	0.088	0.18	0.088	0.33	0.2	0.19

** Value exceeds Utah GW Quality Standard
Refer to Plate 1, Weston Report, Appendix A for monitor well locations

Table 3.4: Richardson Flat Surface Water Sample Data, May 19, 1999 and June 9, 1999

Sample Results Compared to Aquatic Wildlife Criteria

Sample Location	Utah Water Quality Standards		Arsenic[1]	Cadmium	Chromium[1]	Copper	Lead	Mercury	Selenium	Silver	Zinc
RF-6	Aquatic Wildlife	Chronic	0.19	0.004	0.812	0.049	0.026	0.000012	0.005	N/A	0.436
19-May-99	Criteria[2]	Acute	0.36	0.026	6.81	0.085	0.683	0.0024	0.02	0.072	0.481
Diversion Ditch	Lab Results	Dissolved	<0.020	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.15
RF-6	Aquatic Wildlife	Chronic	0.19	0.004	0.812	0.049	0.026	0.000012	0.005	N/A	0.436
9-Jun-99	Criteria[2]	Acute	0.36	0.026	6.81	0.085	0.683	0.0024	0.02	0.072	0.481
75' Downstream of RF-6	Lab Results	Dissolved	<0.020	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.02
RF-7	Aquatic Wildlife	Chronic	0.19	0.004	0.686	0.042	0.02	0.000012	0.005	N/A	0.363
19-May-99	Criteria[2]	Acute	0.36	0.02	5.76	0.07	0.526	0.0024	0.02	0.05	0.405
Upstream Silver Creek	Lab Results	Dissolved	<0.020	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	**0.51**
RF-7-2	Aquatic Wildlife	Chronic	0.19	0.003	0.552	0.033	0.015	0.000012	0.005	N/A	0.292
9-Jun-99	Criteria[2]	Acute	0.36	0.015	4.63	0.055	0.375	0.0024	0.02	0.032	0.322
Upstream of RF-7	Lab Results	Dissolved	<0.020	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	**0.89**
RF-8	Aquatic Wildlife	Chronic	0.19	0.004	0.686	0.041	0.02	0.000012	0.005	N/A	0.366
19-May-99	Criteria[2]	Acute	0.36	0.02	5.76	0.07	0.526	0.0024	0.02	0.05	0.405
Downstream Silver Creek	Lab Results	Dissolved	<0.020	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	**0.49**
RF-8	Aquatic Wildlife	Chronic	0.19	0.003	0.572	0.034	0.015	0.000012	0.005	N/A	0.303
9-Jun-99	Criteria[2]	Acute	0.36	0.016	4.8	0.057	0.396	0.0024	0.02	0.032	0.335
Downstream Silver Creek	Lab Results	Dissolved	<0.020	0.003	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	**0.86**

[1] Aquatic Wildlife Criteria is based on Trivalent species of arsenic and chromium; the sample result is for all species of arsenic and chromium.

[2] Utah Water Quality Standard for Stream Classification 3A (Aquatic Wildlife Criteria) for Dissolved Metals as related to Hardness

General Water Chemistry

Sample Location	Date	Alkalinity	Calcium	Chloride	Cation/Anion Balance	Carbonate	Bicarbonate	Hardness	pH (LAB)	Potassium	Magnesium	Nitrite/Nitrate	Sodium	Sulfate
RF-1	19-May-99	122	39	15	7.5	<1	122	135.27	7.5	<4	9.2	<0.1	18	20
RF-3	19-May-99	198	56	30	6.1	<1	198	197.48	7.8	<4	14	<0.1	32	23
RF-6	19-May-99	214	153	92	5.9	<1	214	530.29	7.7	<5	36	0.6	54	259
RF-6	9-Jun-99	-	187	-	-	-	-	644.01	-	<4	43	0.16	44	-
RF-7	19-May-99	140	122	220	<1	<1	140	432.3	8.2	<4	31	0.4	110	200
RF-7-2	9-Jun-99	-	98	-	-	-	-	331.18	-	<4	21	0.24	80	-
RF-8	19-May-99	142	126	222	<1	<1	142	446.4	8	<4	32	0.6	110	192
RF-8	9-Jun-99	-	102	-	-	-	-	345.29	-	<4	22	0.27	76	-
RF-9	19-May-99	96	82	300	7	4	92	287.11	8.4	6.2	20	0.2	177	50
RF-10	9-Jun-99	-	60	-	-	-	-	219.85	-	<4	17	0.1	47	-

-	-	Flow (cfs)
RF-1	9-Jun-99	0.39
RF-2	9-Jun-99	0.39
RF-6	9-Jun-99	0.32
RF-7-2	9-Jun-99	3.17

Sample Results Compared to Domestic Use Criteria

Sample Location	Date	Type	Arsenic WQS*: 0.05	Barium WQS: 1	Cadmium WQS: 0.01	Chromium WQS: 0.05	Copper WQS: 1	Lead WQS: 0.05	Mercury WQS: 0.002	Selenium WQS: 0.01	Silver WQS: 0.05	Zinc WQS**
RF-1	19-May-99	Total	<0.020	0.16	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.027
		Dissolved	<0.020	0.15	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.047
RF-2	19-May-99	Total	<0.020	0.18	<0.001	<0.020	<0.010	0.005	<0.0005	<0.005	<0.010	0.038
		Dissolved	<0.020	0.17	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.042
RF-3	19-May-99	Total	<0.020	0.17	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.017
		Dissolved	<0.020	0.16	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.024
RF-4	19-May-99	Total	<0.020	0.09	0.002	<0.020	0.015	<0.005	<0.0005	<0.005	<0.010	1.1
		Dissolved	<0.020	0.14	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.95
RF-5	19-May-99	Total	<0.020	0.14	<0.001	<0.020	0.011	<0.005	<0.0005	<0.005	<0.010	0.9
		Dissolved	<0.020	0.14	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.85
RF-6	19-May-99	Total	<0.020	0.13	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.45
		Dissolved	<0.020	0.13	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.15
RF-6	9-Jun-99	Total	<0.020	0.17	0.003	<0.020	<0.010	0.028	<0.0005	<0.005	<0.010	0.85
		Dissolved	<0.020	0.18	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.85
RF-7	19-May-99	Total	<0.020	0.11	0.003	<0.020	0.013	0.074	<0.0005	<0.005	<0.010	0.82
		Dissolved	<0.020	0.1	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.51
RF-7-2	9-Jun-99	Total	<0.020	0.21	0.004	<0.020	<0.010	0.078	<0.0005	<0.005	<0.010	1.5
		Dissolved	<0.020	0.19	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.89
RF-8	19-May-99	Total	0.031	0.13	0.009	<0.020	0.038	0.34	<0.0005	<0.005	<0.010	1.7
		Dissolved	<0.020	0.1	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.49
RF-8	9-Jun-99	Total	<0.020	0.17	0.003	<0.020	<0.010	0.028	<0.0005	<0.005	<0.010	0.85
		Dissolved	<0.020	0.18	0.002	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.85
RF-9	19-May-99	Total	<0.020	0.14	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.011
		Dissolved	<0.020	0.13	<0.001	<0.020	<0.010	<0.005	<0.0005	<0.005	<0.010	0.029
RF-10	9-Jun-99	Total	0.021	0.26	<0.001	<0.020	<0.010	0.023	<0.0005	<0.005	<0.010	0.069
		Dissolved	<0.020	0.25	<0.001	<0.020	<0.010	0.009	<0.0005	<0.005	<0.010	0.009

*Utah Water Quality Standard for Stream Classification 1C (Domestic Use Criteria) for Dissolved Metals.

** There is no WQS for Stream Classification 1C for Zinc.

All units are in mg/L except Flow (cfs) and pH (standard units).

Table 5.2: Summary of Analytical Parameters for Water and Soil Samples

WATER SAMPLES

Analytical Parameters	Method	Reference
Metals		
Ag, As, Ba, Cd, Cr, Cu, Pb, Se, Zn	SW-846 6010	EPA SW-846*
Hg	EPA 245.1	EPA Methods**
Ions		
Ca, K, Mg, Na	SW-846 6010	EPA SW-846*
Cl	EPA 325.2	EPA Methods**
Cation/Anion Balance	-	-
CO_3, HCO_3	EPA 310.1	EPA Methods**
NO_2, NO_3	EPA 353.2	EPA Methods**
SO_4	SW-846 9036	EPA SW-846*
Other Parameters		
Alkalinity	EPA 310.1	EPA Methods**
pH (lab)	EPA 150.1	EPA Methods**
pH (field)	Digital pH Meter	RMC SOP
conductivity	Digital Meter	RMC SOP
Hardness	-	-
TSS	EPA 160.2	EPA Methods**
TDS	EPA 160.1	EPA Methods**

SOIL SAMPLES

Analytical Parameters	Method	Reference
Metals (Soil)		
Ag, As, Ba, Cd, Cr, Cu, Pb, Se, Zn	SW-846 6010	EPA SW-846*
Hg	SW-846 7471	EPA SW-846*
Metals (Sedimentary)		
Ag, As, Ba, Cd, Cr, Cu, Pb, Se, Zn	XRF	-
Hg	SW-846 74.71	EPA SW-846*
Other Parameters		
Cation Exchange Capacity	SW-846 9081	EPA SW-846*
pH (lab)	SW-846 9045C	EPA SW-846*

* EPA SW-846 Test Methods for Evaluating Solid Waste, December, 1996
** EPA Methods for Chemical Analysis of Water and Waste, March, 1983

APPENDIX A: The Weston Preliminary Hydrogeologic Review of Richardson Flat Tailings Site

PRELIMINARY HYDROGEOLOGIC REVIEW OF RICHARDSON FLATS TAILINGS SITE

SECTIONS 1 AND 2
TOWNSHIP 2 SOUTH, RANGE 4 EAST
SUMMIT COUNTY, UTAH

EPA ID# UT980952840

March 23, 1999

Prepared For

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PRELIMINARY HYDROGEOLOGIC REVIEW OF RICHARDSON FLATS TAILINGS SITE

STATEMENT OF THE PROBLEM

Richardson Flats covers an area encompassing approximately 700 acres in a small valley located about 1.5 miles northeast of Park City, Utah. The Environmental Protection Agency (EPA) placed the site on the CERCLIS listing as EPA ID# UT980952840 and nominated the site to the National Priorities List (NPL) in 1992 due to the presence of potentially hazardous substances associated with disposal of mill tailings on approximately 160 acres; however, the site has not been listed on the NPL. An abundance of investigative work was completed by design consultants working on behalf of various mining companies to design the tailings impoundment during the 1970s and early 1980s. EPA contractors commenced reconnaissance-level environmental investigations in support of the Hazard Ranking Scoring (HRS) in the 1980s. However, prior to 1999, little work was conducted on developing a hydrogeologic conceptual model using the readily-available information.

PURPOSE AND SCOPE OF REPORT

The purpose of this report is to present a conceptual hydrogeologic model of the Richardson Flats site focusing on the occurrence and movement of groundwater. The mutually-agreed upon scope of work between LeBOEUF, LAMB, GREENE & MacRAE, L.L.P. and Weston Engineering, Inc. (WESTON) involved the following tasks:

- Perform initial field measurements and observations;
- Compile available historic and current data;
- Develop initial conceptual model of groundwater occurrence, interaction with surface water, and direction and magnitude of hydraulic gradients and groundwater flow;
- Identify data gaps and locations where additional information is needed;
- Establish new data collection points, if needed;
- Integrate new information with existing information;
- Refine conceptual hydrogeologic model; and
- Prepare this summary report.

This summary report is based on geologic and hydrologic data contained in published and unpublished reports, as well as field observations made during a confirmation drilling and hydrogeologic data collection program completed in January and February, 1999. Water quality issues are not a part of this investigation.

HYDROGEOLOGIC SETTING OF RICHARDSON FLATS

Location

Richardson Flats is located in Sections 1 and 2, Township 2 South, Range 4 East in Summit County, Utah. The tailings impoundment is located within a few hundred feet of Silver Creek, a perennial stream draining the Park City area where other historic tailings ponds were located (see Mason, 1989).

Structural Geology

While the Richardson Flat tailings pond is located within a complex fold and thrust belt later intruded and overlain by volcanic rocks, mapping by Bromfield and Crittenden (1971) place no faults near the site (see Geologic Map Inset - Plate I). Examination of low-altitude aerial photography indicates that the volcanic rocks near the site are fractured; linear ridges in the surface topography indicate potential faults near Homer Spring and along a northeast-southwest trending ridge located east of Keetley Junction.

Stratigraphic Setting Based on Historic Data

EPA records indicate that the Richardson Flat tailings pond was apparently constructed during 1953 on alluvium and colluvium derived from Silver Creek and the attendant subsidiary drainages. The alluvium and colluvium is approximately 30 to 50 feet thick on the basis of logs of geotechnical borings and studies completed as part of the improvements to the reconstruction of the tailings pond in the 1970s, in addition to the logs of monitoring wells installed to assess groundwater impacts in the 1980s (see Dames & Moore, 1973; 1974; 1980; and Ecology and Environment, 1985). While the data distribution is less than ideal, the available information indicated the following materials comprise the stratigraphy of the alluvial and colluvial debris:

- Two-to-five feet of soft, organic and clay-rich topsoil;
- One-to-30 feet of various mixtures of fine-grained silt and clay;
- Four feet of sand and gravel; and
- Variable thickness of highly-weathered volcanic breccia composed of relatively soft, tight, sandy and silty clay grading to moderately hard, slightly to moderately fractured volcanic rocks.

Recent exploratory drilling by the Park City Municipal Corporation at a site located approximately one mile northwest of the tailings pond determined that the underlying Keetley volcanic rocks may be more than 1,000 feet thick (see Geologic Map Inset - Plate I). Mapping by Bromfield and Crittenden (1971) indicate that well-indurated Mesozoic and Paleozoic limestones, sandstones, and shales may underlie portions of the Richardson Flats area. Holmes and others (1986) report that some of these rock units serve as aquifers where saturated and permeable.

The tailings overlie the topsoil composing the original surface grade. The dark-colored, clay-rich organic topsoil was consistently logged by the various geotechnical and environmental investigations, and serves as the best horizon to correlate between the widely-spaced borings. The pre-tailings topography of the area was integrated with the test pits located within the tailings pond to estimate the thickness of the tailings. These data indicate that the thickness of the tailings is approximately 10 to 18 feet and perhaps thicker along the northern boundary.

Hydrogeologic Overview Based on Historic Data

Examination of the historic boring and well logs in the area indicated that at least four shallow groundwater systems may be found in the Richardson Flat area:

- Shallow alluvium with possibly a perched water table;
- Deeper alluvium composed of confined sand and gravel aquifer(s);
- The underlying and adjacent fractured Keetley volcanic rocks; and
- The impounded tailings.

Alluvium. The boring log for the upgradient monitoring well installed by Ecology and Environment (1985; see RT-1 in Attachment No. 1) reveals that water was first encountered at a depth of 17 feet within primarily red-brown clay and gravely sand; deeper drilling encountered yellow-gray clay from 15 to 23 feet, red-brown sandy clay from 23 to 34 feet, and gravel yielding 10 to 15 gallons per minute (gpm) from 34 to 38 feet. Following completion of the boring as a monitoring well with screens set across both intervals where water was reported, the static water level was found at 9 feet below ground surface. Because the post-completion static water level was higher than the "first" water, one reasonable interpretation of the limited post-completion data is that (1) the boring initially encountered a water table aquifer; (2) deeper drilling encountered a sand and gravel zone under confined conditions; and (3) the completed well connected these two previously separate aquifers.

Keetley Volcanics. The underlying weathered and unweathered Keetley volcanic rocks have low intrinsic permeabilities and yield low quantities of groundwater to wells and springs. Dames & Moore (1974) report that the low hills located north of the impounded tailings are covered by dark brown, stiff, clay of varying thickness; three to four feet of this material was encountered in Test Pit Nos. 20 and 21 (see Plate I). Dames & Moore (1974) further report the clayey material grades with some sand and dense clayey sand indicative of highly weathered volcanic breccia.

Park City Municipal Corporation recently installed a test well in the southeast corner of Section 34, Township 1 South, Range 4 East, approximately one mile northwest of the tailings pond. The well was spudded on the weathered Keetley Volcanics with the underlying Thaynes Limestone as the targeted aquifer. However, the Thaynes Limestone was not encountered at the final drilled depth of 1,000 feet. While the exploratory boring developed water from the fractures in the unweathered Keetley volcanic rocks, the quantity of water that could be reasonably developed from the Keetley Volcanics at this location was between 100 to 200 gpm with long-term drawdown estimated at 250 to 300 feet (specific capacity = 0.33 to 0.4 gpm per foot of drawdown (gpm/ft) or a transmissivity of 30 to 50 ft^2/day). This yield was considerably less than the quantity desired by Park City for a municipal water supply, and the well remains unused (see Hansen, Allen & Luce, 1996).

No water quality samples were collected from this well for analysis of potability; however, Hansen, Allen & Luce (1996) imply that the water quality may be suitable for short-term irrigation. Nearby springs also discharge water at approximately four to eight gpm with low total dissolved solids (TDS) from these volcanic rocks (Holmes and others, 1986; Downhour and Brooks, 1996).

Impounded Tailings. Based on the test boring installed by Ecology and Environment (1985; see RT-2 in Attachment No. 1), the tailings were partially saturated. Water level measurements made during the 1973 and 1974 design phases of the tailings pond development, coupled with the 1985 water level measurements, indicated that the lower 15 feet of the tailings were saturated. Cursory examination of the historic water level data indicated that the groundwater within the tailings flowed from southeast to northwest under a gentle hydraulic gradient (0.0031).

PRELIMINARY CONCLUSIONS BASED ON AVAILABLE HYDROGEOLOGIC DATA

On the basis of the historic records, uncertainty existed regarding (1) the degree of saturation within the tailings; (2) the hydraulic connection between water stored in the tailings and the shallow alluvial aquifer(s); (3) the hydrologic characteristics of the shallow aquifer(s) with respect to water table or confined conditions; (4) the hydraulic connection between the shallow aquifer(s) and Silver Creek; and (5) the hydraulic gradient in the shallow aquifer(s) between the historic landfill investigated by Ecology and Environment (1993) and the tailings embankment (see Plate I for location of historic landfill monitoring wells).

Supplemental work was conducted during early 1999 to build upon rather than duplicate the previous work efforts. This work included:

- Installation of piezometers within the tailings pond to determine whether the tailings remain partially saturated;
- Installation of piezometers outside the tailings pond to compare and contrast the hydraulic head across the embankment to evaluate the degree of hydraulic connection, if any, between the impounded tailings and shallow aquifer(s), and between Silver Creek and the shallow aquifer(s);
- Confirmation of the apparent upward hydraulic gradient indicated by the upgradient monitoring well (RT-1) installed by Ecology and Environment (1985); and
- Better characterization of the hydrogeology between the historic landfill and the downgradient tailings embankment.

SUPPLEMENTAL SOIL SAMPLING AND WATER LEVEL MEASUREMENT PROGRAM

Drilling and Piezometer Installation

Geotechnical borings and small-diameter piezometers were installed using direct-push and hollow stem auger methods during the week of January 25, 1999. Plate I depicts the locations of the supplemental drilling locations, in addition to the numerous historic test pits, borings, and existing monitoring wells in and near the tailings pond. Note the piezometer numbering system for the recent drilling program follows that employed by Ecology and Environment (1985). Ecology and Environment (1985) designated their hydraulically upgradient well as RT-1 and the boring within the tailings as RT-2. Other borings installed during this investigation were labeled in sequence of installation beginning with RT-3. Shallow borings designed to test the presence of shallow aquifer(s) were designated with the letter "A" following the boring number and the deeper borings designed to test for deeper aquifer(s) were designated with a letter "B". The lithologic logs and a description of the as-built configuration for the individual piezometers can be found in Attachment No. 1.

The supplemental lithologic information indicated the following materials, from top to bottom, comprise the stratigraphy of the tailings pond and the underlying and adjacent alluvial and colluvial debris:

- Clay-rich artificial fill derived from the burrow area depicted on Plate I and capping the impounded tailings approaches one foot in thickness;
- Fine-grained sand tailings approximately 16 to 18 feet thick in the central portion of the tailings pond, and perhaps thicker along the northern boundary;
- Two-to-five feet of clay-rich organic pre-tailings topsoil found in every test pit and boring in the tailings;
- Approximately 15 feet of reddish-brown mixtures of silt and clay;
- Two-to-six feet of reddish-brown gravelly clay;
- Two-to-ten feet of reddish-brown to yellow-brown mixtures of silt and clay; and
- Two-to-ten feet of clayey sand and gravel.

Plate I provides conceptual hydrogeologic cross sections summarizing the local distribution of the various lithologies by integrating the historic test pits, borings, and supplemental borings.

Clay Mineralogy Analysis

Knowledge of the clay mineralogy in fine-grained soils provides information on the engineering behavior of soils and potential attenuation capacity for certain contaminants. Selected soil samples from boring RT-5 were analyzed using X-ray diffraction (XRD) techniques to better characterize the mineralogy of the fine-grained sediments overlying and underlying the tailings. Samples from boring RT-5 were selected because the materials encountered included the best representation of (1) the artificial cap overlying the tailings, (2) the clay-rich organic topsoil found beneath the tailings, and (3) the clay-rich soils found beneath the top soils which created confined conditions in the deeper saturated soils. A discussion on sample preparation methods and copies of the various figures referenced below can be found in Attachment No. 2. The rectangular boxes beneath the individual XRD traces are XRD peaks for standard patterns prepared by the Joint Committee on Powder Diffraction Standards (JCPDS) which can be accessed by the computer serving the XRD device.

Artificial Cap. Material for the artificial cap was derived from the weathered volcanic rocks on the low hills north of the tailings impoundment. XRD results for the sample of the artificial fill capping the tailings found from 0 to 0.7 feet closely match the XRD peaks for illite and kaolinite. Kaolinite is the most prevalent clay mineral and is stable with little tendency for volume change when exposed to water. Illite is generally more plastic than kaolinite and does not expand when exposed to water.

Native Soil Beneath Tailings. The sample of the clay-rich organic topsoil found below the tailings at approximately 11 feet in depth, in addition to the underlying sandy clay found between 13 and 14 feet, closely match the XRD peaks for the clay mineral sepiolite. The characteristic peak at a d-spacing of 12Å does not match any other "simple" clay minerals. However, it is possible that the clay identified as "sepiolite" is in fact a rather ill-defined mixed-layer clay mineral (mixed mica and illite or smectite, for example) which can be found in relatively immature soils on granitic bedrock. The distinction cannot be made without further analysis. Smectite readily absorbs water between clay layers yielding large volume changes because of this property. Likewise, because of the weak bond between layers, various contaminants can be absorbed by the mixed-layered clays.

Groundwater Occurrence and Circulation Model

Because of the fine-grained texture of the shallow aquifers, the water levels in the recently-installed piezometers were allowed to stabilize for at least four days following installation prior to measurement. A summary of the water level measurements can be found both on the individual boring logs, and in the table provided on Plate I. The point of reference for all measurements is the ground surface next to the individual piezometer or well. Elevations of selected water surface locations along Silver Creek and the diversion ditch located south of the tailings pond were also surveyed for points of reference, as indicated on Plate I.

The recent water level measurements in the local wells and piezometers indicate that the three principal shallow groundwater systems underlying the Richardson Flats area are as follows:

- Shallow alluvium along Silver Creek under unconfined conditions;
- Deeper alluvium and colluvium composed of confined sand and gravel aquifer(s) mixed with abundant fine-grained materials; and
- The impounded tailings under unconfined conditions.

Confined Aquifers. Groundwater stored in the saturated and permeable strata comprising the shallow aquifers adjacent to the tailings pond is found under confined conditions in at least three discrete intervals. Examination of the hydrogeologic cross section A-A' depicted on Plate I reveals the first water bearing interval is found at approximately 15 to 20 feet in depth. The deeper water bearing intervals are found between 25 to 35 feet in depth. Because the water levels in piezometers RT-1A/B and RT-8A/B rise above the top of the identified aquifers, the low permeability fine-grained silt and clay found overlying and layered between the shallow and deeper aquifers serve as effective confining strata.

The hydraulic communication between the shallow and deeper water bearing intervals appears to be poor. Examination of the water level elevations measured in February, 1999 and summarized on the table on Plate I indicates nearly 0.4 feet of head difference between the shallow and deeper aquifers in the vicinity of RT-1A/B. The hydraulic gradient between these aquifers is downward at this location. Likewise, the water levels in the piezometer series RT-8A/B indicates a similar hydrologic relationship with the exception that the hydraulic gradient between the deeper and shallow aquifer is upward (see hydrogeologic cross section A-A'). Mason (1989) reported a downward component of groundwater flow similar to that observed at Richardson Flats in the unconfined to semi-confined unconsolidated valley fill aquifer(s) underlying the Silver Creek tailings site near Prospector Square.

Groundwater in Impounded Tailings. The depth to water below the artificial fill cap on the impounded tailings is approximately three to five feet (see cross sections A-A' and B-B' on Plate I). Examination of section B-B' reveals some uncertainty regarding the free water surface in the tailings pond because the tailings and underlying materials open to piezometer RT-4 are unsaturated. Likewise, the tailings encountered in boring RT-5 are also unsaturated. For example, the boring encountered unsaturated tailings to a depth of 10.8 feet and was completed in silty sand and sandy clay materials to a depth of two feet below the tailings-topsoil interface (see Boring Logs in Attachment No. 1). However, the water level in piezometer RT-5 is found at an elevation of approximately two feet higher than the elevation of the water levels in the tailings piezometers RT-3 and RT-6.

While the source of the water stored in the tailings remains unknown, reasons for the unsaturated tailings include (1) evaporation prior to capping with artificial fill, (2) the artificial fill cap is composed of low permeability clay-rich material which effectively precludes downward flow of ponded surface water, (3) low-rate leakage across the tailings embankment, and (4) combinations of all of the above. Water level measurements collected during March, 1999 indicate that water levels rose in all piezometers on the order of one to two feet (see table on Plate I). Mason (1989) observed the water levels varying seasonally in monitoring wells completed in the unconsolidated fill near the Silver Creek tailings site, with the season high occurring during March and April. The effects of snow melt and storm water collecting in the tailings pond requires additional study.

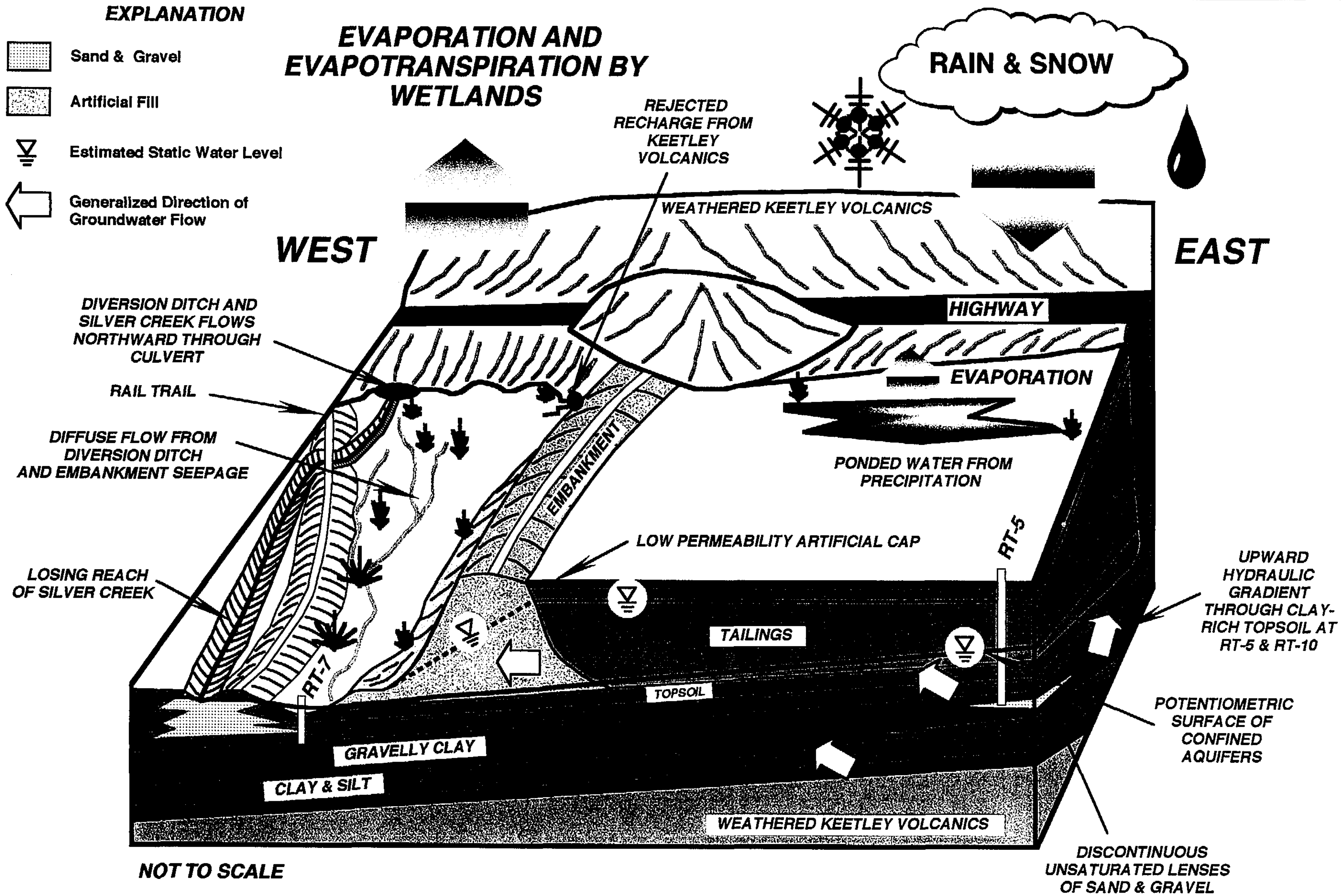
Hydrologic Role of Clay-rich Organic Topsoil. The anomalously high water level elevation in piezometer RT-5 is attributed to the hydrologic confining properties of the clay-rich organic topsoil. Examination of the boring log for RT-5 indicates the original topsoil is found at 10.8 feet in depth and the overlying tailings are damp. Deeper drilling found the topsoil damp, becoming increasingly saturated with depth. The underlying silty sand is saturated. The sandy clay beneath the silty sand is moist, yet the deeper gravelly sand found at 14 feet is only damp to moist. The depth to water at RT-5 is 7.3 feet below the ground surface, approximately 3.5 feet above the interface between the unsaturated tailings and the original topsoil.

A hydrologic relationship similar to that defined at piezometer RT-5 is found at piezometer RT-10 located approximately 2,900 feet south of the impounded tailings (see Plate I). The initial 3.5 feet of fine-grained, organic-rich clay and silt soils are partially saturated. The silty sand encountered below 3.5 feet is saturated, and the depth to water in the completed piezometer is 1.1 feet below ground surface. All of these data indicate the topsoil is a low permeability confining layer overlying the shallow aquifers and underlying the tailings at the Richardson Flats site.

Volcanic Rocks. While the underlying and adjacent weathered and unweathered Keetley volcanic rocks may constitute a deeper aquifer, no piezometers were installed in these rocks for the supplemental investigation because the supplemental soil sampling and water level information indicated the shallower aquifers were separated by low permeability confining strata. For example, the artificial fill capping the impounded tailings was derived from the burrow area depicted on Plate I. Percolation tests completed on selected samples of the artificial fill indicated low permeabilities (see Plate I). Likewise, Dames & Moore (1973) indicated that while the permeability of the unweathered and fractured volcanic rocks would be greater at depth, the weathered surface of the volcanic rocks would nearly eliminate seepage to greater depths. An aquifer interference test designed to determine the possible effects of pumping a large capacity well serving Park City Municipal Corporation which was completed in fractured carbonate rocks underlying the unconsolidated sediments along Silver Creek confirmed this apparent lack of hydraulic communication between the shallow and deep alluvial aquifer systems near the Silver Creek tailings site (see Mason, 1989, p. 33)

Generalized Groundwater Flow Model. Examination of the potentiometric surface elevations depicted on Plate I indicates that groundwater flows from areas of higher hydraulic head located south of the tailings pond northward to areas of lower hydraulic head. On the basis of the water level measurements of Silver Creek located west of the impounded tailings and the water level measured in piezometer RT-7, the water surface in Silver Creek is found at a higher elevation than in the adjacent low area. Likewise, groundwater stored in the alluvium at piezometer RT-9 is also found at a higher elevation than the water surface of the pond located along the diversion ditch (see Plate I). Groundwater stored in the shallower aquifers overlain by the clay-rich organic topsoil apparently flows towards the diversion ditch as indicated by the elevations of the potentiometric surface measured in piezometers RT-8 A/B and RT-5.

On the basis of the historic and supplemental geologic and hydrologic data, a hydrogeologic conceptual model of the Richardson Flats area is depicted on Figure 1. Precipitation and snow melt serve as: (1) the principal sources of recharge to the groundwater system; (2) perennial flows to Silver Creek; and (3) surface water ponding on the impounded tailings. The shallow aquifers are primarily confined by low permeability clay and silt layers. The clay-rich organic topsoil also serves as a confining layer. On the basis of stream flow measurements by Holmes and others (1986) and surveyed water level measurements made during this study, unconfined aquifers occur locally within the alluvium along Silver Creek where the creek serves as both a gaining and a losing stream. Groundwater flow in the shallow aquifers is primarily



WESTON
GROUNDWATER · ENGINEERING

HYDROGEOLOGIC REVIEW
RICHARDSON FLATS TAILINGS SITE
PRELIMINARY CONCEPTUAL MODEL OF SHALLOW AQUIFER GROUNDWATER FLOW SYSTEM
FIGURE 1

upward in the vicinity of the tailings impoundment and directed towards the diversion ditch and Silver Creek, both serving as local hydraulic sinks. Discharge to low areas occurs along the toe of the embankment as water stored in the impounded area seeps through the embankment as originally designed as an engineered structure. Seepage also apparently occurs along the northern extent of the embankment which may reflect rejected recharge from the weathered volcanic rocks or water seepage from the impounded tailings. As indicated in the following section, the bulk of the seepage across the tailings embankment as well as the diffuse flow from the diversion ditch completes the hydrologic cycle by evaporation or evapotranspiration through consumptive use by the wetlands located in the low area between the tailings embankment and Silver Creek.

ESTIMATES OF GROUNDWATER DISCHARGE ACROSS TAILINGS EMBANKMENT

On the basis of the February, 1999 water level data collected in the piezometers completed within the impounded tailings and comparing these data to the water levels in the embankment wells, the difference in hydraulic head across the embankment approaches 17 feet. Integrating the observed difference in hydraulic head with the assumption that the footprint of the embankment approaches 400 feet, yields a hydraulic gradient of 0.0425 (see Plate I, section B-B'). Assuming that the water level data collected in February, 1999 within the impounded tailings reasonably reflects current conditions, first-order approximations of seepage rates across the tailings embankment can be made with permeability data derived from percolation tests completed by Dames & Moore (1973; 1974; 1980) and Applied Geotechnical Engineering Consultants, Inc. (1999). A summary of the permeability data for various earth materials located in and near the tailings embankment is provided in Table I.

TABLE I
HYDRAULIC CONDUCTIVITY MEASUREMENTS OF RICHARDSON FLATS MATERIALS
SUMMIT COUNTY, UTAH

Media	Sample Location	Hydraulic Conductivity (ft/year)
Artificial Fill Cap	See Plate I	0.031 to 0.072*
Natural Soil	TP-8**; UPCMC Well No. 3***	0.001 to 5**
Rock	UPCMC Well Nos. 1,2, 3	0.6 to 1**
Tailings and Slimes	TP-1,2,3,4	3 to 4,000**
Recompacted Soil	TP-20	1**
Recompacted Tailings	TP-17	20 to 45**
Recompacted Gravel Pit Material	Near TP-6	75 to 82**

* Reported values represent unit conversions of data reported by AGEC (1999) listed in Attachment 3.
** Test Pit Locations and data from Dames & Moore (1973; 1974) - See Plate I.
*** UPCMC = United Park City Mines Co. Well Numbering System - See Insert on Plate No. 1.

A range of values were incorporated into the analysis because Dames & Moore (1980) reported the following conditions: (1) the embankment was not constructed using engineered fill; (2) the internal zoning of the embankment was not constructed as recommended by the design engineer; (3) the main embankment and adjoining dike were constructed largely of silty sand and gravel; and (4) the southeastern portion of the embankment was constructed of clay and gravelly clay derived from areas near Highway 40 located north of the impounded tailings. Using the best available estimates of hydraulic gradients, the seepage across the tailings embankment can be estimated using the Darcy equation:

$$q=kia$$

where **q** is the Darcy flux or volumetric flow rate per unit area per unit time; **k** is the saturated hydraulic conductivity; **a** = area; and **i** is the hydraulic head gradient. Substitution of the variables into the Darcy equation yields estimates of seepage across the tailings embankment as summarized in Table II.

Based on these simple calculations, reasonable estimates of the seepage rates across the embankment face range from approximately 0.6 to 63 gallons per day. Use of the higher end of the range for the hydraulic conductivity of the tailings and slimes to estimate seepage rates is not justified because the available water level elevation data indicates that the tailings embankment impedes groundwater flow (see Embankment area on Plate I, section B-B').

TABLE II
CALCULATED SEEPAGE RATES ACROSS
RICHARDSON FLATS TAILINGS EMBANKMENT
SUMMIT COUNTY, UTAH

Hydraulic Conductivity (ft/year)	Representative Medium	Calculated Seepage Across Main Embankment Area = 900 ft x 6 ft* (gallons per minute)	Calculated Seepage Across Main Embankment (gallons per day)
1	Recompacted Soil	0.0004	0.63
5	Natural Soil	0.0022	3.14
20	Recompacted Tailings	0.0087	12.57
100	Recompacted Gravel Pit Material	0.044	62.87
4,000	Tailings and Slimes	1.75	2,515

* Embankment area assumed to be main embankment area located at western margin of tailings pond on Plate I.

Evaporation Losses

Dames & Moore (1973) used a simple hydrologic budget analysis to determine evaporative losses in the impounded tailings as part of the impoundment design. Their analysis determined that 0.6 to 0.8 gpm per acre is lost to evaporation. Considering that the triangular-shaped land area located west of the embankment and Silver Creek approaches 5.5 acres in size and integrating the estimates of evaporation by Dames & Moore (1973) indicates that between 2,400 and 3,200 gallons per day is evaporated in the area where seepage losses would be expected to occur below the embankment (this analysis assumed that evaporation occurred on a diurnal basis on a cycle of 12 hours per day).

Wetland Consumptive Use

Studies summarized by Brooks and others (1998) and Holmes and others (1986) indicate that consumptive use by phreatophytes and riparian habitats ranges from 2.4 to 2.6 acre-feet per acre per year (ac-ft/ac/yr). Assuming that all of the triangular area located between the embankment and Silver Creek is covered by wetlands, and incorporating the available consumptive use data yields first-order approximations of evapotranspiration approaching 12,000 gallons per day. Examination of the available color aerial photography of the Richardson Flats area indicates that not all of this area is covered with the same type of vegetation. Considering that perhaps 20 percent of the area is covered with wetlands indicates that a reasonable range of wetlands consumptive use ranges from 2,400 to 12,000 gallons per day.

Contribution to Silver Creek

According to Pioneer Technical Services (1993) and Downhour and Brooks (1996), estimated flows in Silver Creek near Richardson Flats average 3.3 to 3.65 cubic feet per second (1,480 to 1,635 gpm). Likewise, estimated flows in the diversion ditch located along the southern margin of the tailings pond average 0.06 cubic feet per second (27 gpm; Pioneer Technical Services, 1993). Based on WESTON's initial site visit on November 24, 1998, WESTON staff estimated flows in the diversion ditch to approach 100 to 200 gpm near United Park City Mines Company Monitoring Well No. 3 (see Well Location Map Inset on Plate I). Recalling the potentiometric surface data collected in the area west of the tailings embankment indicate the water surface in Silver Creek is found at a higher elevation than the potentiometric surface measured in piezometer RT-7 located between Silver Creek and the tailings embankment, the apparent hydraulic contribution, if any, of tailings embankment seepage to surface water features is negligible.

CONCLUSIONS

The following conclusions were reached on the basis of the historic and supplemental hydrogeologic data collected in the Richardson Flats area:

- The tailings are partially saturated;
- The tailings are deposited on the naturally occurring pre-tailings topsoil;
- The organic-rich clayey pre-tailings topsoil serves as an effective confining layer;
- The shallow aquifer(s) are under confined conditions;
- Monitoring well RT-1 is apparently open to at least two shallow aquifers in an area where groundwater in the shallower aquifer flows downward to the deeper aquifer with lower hydraulic head;
- Groundwater flows from areas of higher hydraulic head located south of the tailings pond northward to areas of lower hydraulic head;
- Beyond seepage across the tailings embankment, there is no apparent hydraulic connection between groundwater stored in the tailings and underlying and adjacent to shallow alluvial aquifer(s);
- First-order approximations of seepage rates across the tailings embankment range from approximately 0.6 to 63 gallons per day;
- First-order approximations of consumptive use of seepage from the tailings embankment by the one to five acres of wetlands located west of the embankment range from approximately 2,400 to 12,000 gallons per day;
- Silver Creek is found at a higher elevation than groundwater stored in the shallow aquifer(s) located between the tailings embankment and Silver Creek;
- The apparent hydraulic contribution, if any, of tailings embankment seepage to surface water features is negligible;
- The artificial fill capping the tailings is low-permeability material derived from local sources and is composed of illite and kaolinite; and
- The effects of snow melt and storm water ponding in the tailings pond requires additional study.

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ATTACHMENT NO. 1
BORING LOGS

FIELD LOG OF BORING

DEPTH BELOW LAND SURFACE (feet)	GRAPHIC LOG	PROJECT: Richardson Flats R8-8505-27 — BORING NO.: RT-1 DESCRIPTION	SAMPLE INTERVAL	BLOW COUNTS/ 6 in.	COMMENTS
1.5		Topsoil - Dk. Brn, Sandy			
4.0		Dk Red-Brn Sandy, Clayey	5'-7' SS-1		
15		DK Red Brn Gravelly Sand	10-12' SS-2		
23		Pale Yellow-Brn Clay, Sandy, Water@17'			
31		DK Red-Brn Sandy Clay w/Gravel			
32		Pale Yellow Grey Clay			
34		DK Red Brn Sandy Clay w/Gravel			
36		Gravel, Clean, 1/4"-1/2" diam., (Water 10-15gpm)			
38		T.D. Yellow-grey, Clay			

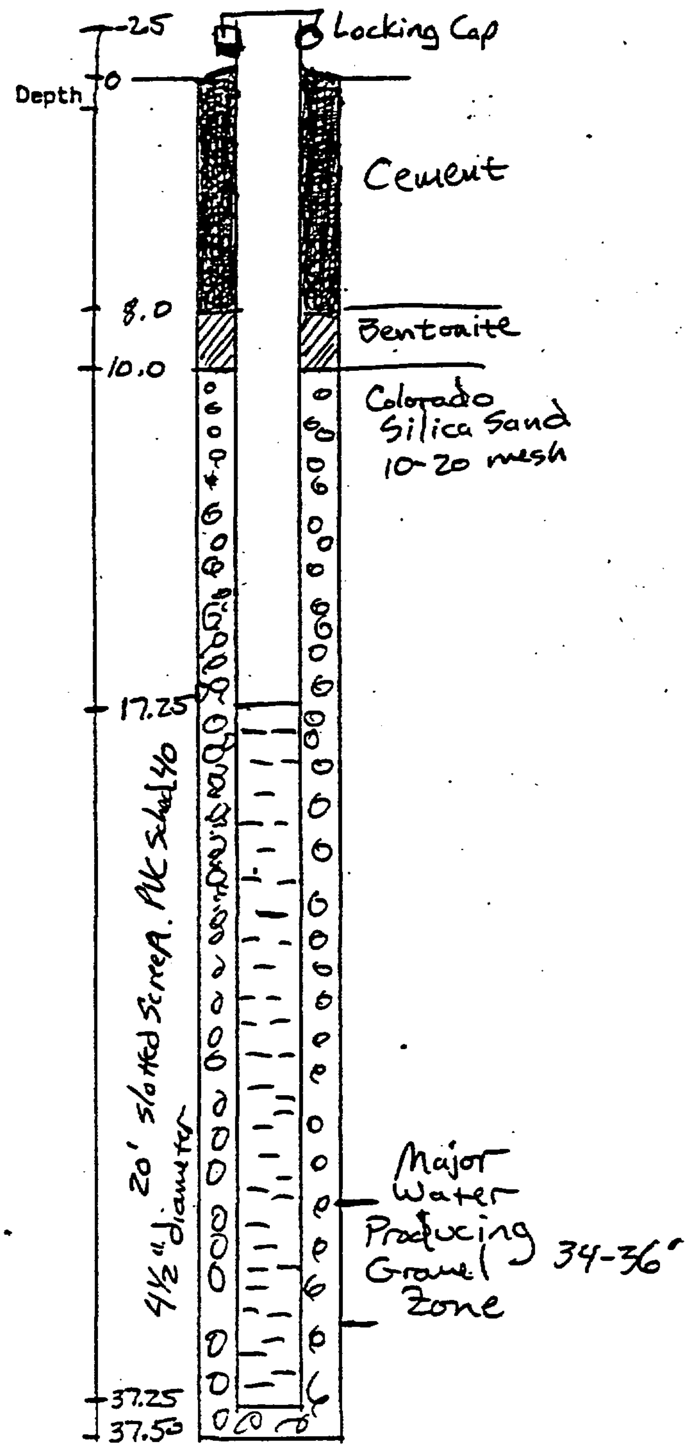
WELL/PIEZOMETER COMPLETION DIAGRAM

Piezometer Number: Well # ~~[illegible]~~ RT-1

Project: Richardson Flats R8-8505-27

Aquifer: Shallow-Alluvial

Static Water Level: ~9'



Geologist: Rob Smith

Driller: Dave's Drilling - Heber City, UT

Date of Installation: 8/1/85

Hole Depth: 37.5'

Stickup: 2.5'

Protective Casing: -2.5' to 2.5' Total 5'

Well Casing: -2.5' to 37.5' Total 40'

Top Seal

Cement from 0' to 8'

Bentonite from 8' to 10'

Hole Diameter: 7⅞"

Casing Diameter: 4½" i.d.

Well Casing Depth: 37.25

Screen Diameter: 4½" slots =

Centralizers: Top of Screen @ 17.5'

Pump Type: —

Pump Capacity: —

Pump Setting: —

Average Pumping: —

Remarks: Developed by bailing. 185 gallons purged.

DRILLING LOG

Well/Boring Number Well RT-1 (upgradient)
Project Richardson Flats Tailings
Project Number R8-8505-27
Date Started 8-1-85
Date Completed 8-1-85

Geologist Rob Smith
Driller Dave's Drilling
Geophysical Logger ——
Permit Number ——
Property Owner Park City Mines, Inc.

LOCATION

N. ____
E. ____
Elevation 6650' ± 10'

SW 1/4 of NE 1/4 of SE 1/4
Section 2 T 2S R 4E
County Summit State Utah

Drilling Method Air Rotary/Casing Drive
Samples 2 Piezometer
Rig Make and Model Chicago Pneumatic CP-7000
Drill Bit Diameter 7 7/8" (2" split spoon sampler)

Logs
Res. SP Gam. G-Den. Neut. Calip. Dev. Sonic
Pipe dope used

DRILLING, CORING, BIT AND CASING RECORD

Diameter	Depth From	Depth To	Notes
7 7/8"	0	2	Topsoil
	2	15	Red Brn Sand
	15	23	Yell. Clay
	23	34	Red Sand
	34	38	Gravel

ADDITIVES USED

Depth From	Depth To	Additives

Notes: Two Split Spoon Samples Collected (5-7' + 10-12')
Well completed @ 38', W.L. at ~9'.

RICHARDSON FLATS

ID# UT980952840

BORINGS 1A/1B SERIES

Depth Interval (feet) From	To	Description
0	1.5	CLAYEY SILT: Moderate brown, some dusky brown organic material and fine roots, blocky.
1.5	2.3	CLAYEY SILT: Moderate brown, some dusky brown less organic material and fine roots, firm, damp.
2.3	4.6	CLAYEY SILT: Moderate brown w/ moderate orange pink mottling, stiff, dry.
4.6	4.7	SILTY SAND: Moderate brown, fine to coarse grained, loose, dry to damp.
4.7	11.7	CLAYEY SILT/SILTY CLAY: Moderate brown, 5% sand, stiff, damp to moist, moderate orange pink mottling disappears below 6 feet.
11.7	14.8	SILTY SAND: Moderate brown, fine sand to fine gravel, loose, coarsens with depth, clayey @14.3 to 14.6 feet, damp.
14.8	16	SILTY CLAY: Moderate reddish brown to moderate yellowish brown, firm to very stiff, damp to moist.
16	16.7	CLAYEY SAND AND GRAVEL: Moderate reddish brown, fine sand to fine gravel, 50% silty clay, loose, saturated.
16.7	19	SILTY CLAY: Moderate brown to moderate reddish brown, stiff, damp to moist.
19	22.2	GRAVELLY CLAY: Moderate reddish brown, sandy from 20.2 to 20.8 feet, moist to wet.
22.2	27.5	SILTY CLAY: Moderate yellowish brown, 10% fine to coarse sand, stiff, very stiff @ 25 feet, damp. Lost core from 27 to 31 feet.
27.5	33	CLAYEY GRAVEL: Gravel @ 27.5 feet based on drilling characteristics-clayey gravel from 27.5 to 33 feet.
33	34	CLAY: Yellow brown clay, stiff @ 33 to 34 feet.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 12.80 feet below ground surface on 2/2/99 in RT-1A; 12.65 feet below ground surface on 2/2/99 in RT-1B.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 16.5 to 11.5 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 4 feet. Bentonite chips from 4 feet to ground surface.

FIELD LOG OF BORING

DEPTH BELOW LAND SURFACE (feet)	GRAPHIC LOG	PROJECT: Richardson Flats R8-8505-27 — BORING NO.: RT-2 (Tailings) DESCRIPTION	SAMPLE INTERVAL	BLOW COUNTS/ 6 in.	COMMENTS
0.8		Lt Grey, Sand, No Sulfides, Carbonate			
1.2		Grey Brown, Clay-Silt, Sulfides, Carbonate	SS-3		
1.3		Lt Grey, Sand, No Sulfides, Carbonate	Oxidized		1.0-3.5
3.5		Lt Brown, Clay Silt, Sulfides, Carbonate			
11.0		DK Grey, Sand-Silt, Sulfides, Carbonate	SS-4 red		3.5-7.5
12.5		Lt Brn, Grey, Sand, Gravel, Carbonate + Sulfide		▽ 12'	
14.0		Lt Grey, Tan, Coarse Sand + Gravel, Carbonate + Sulfide			
16.0		No Recovery	SS-5 Bottom		
17.6		Lt Grey-Tan Coarse Sand + Gravel, Carbonate			12-17.8 w/o ~~14~~-16
17.7		DK Grey-Black, Clay, Sulfides			
18.0		DK Brn, Clay-Silt - Native Soil	SS-6 Under		17.7-18
22		Gravel - Partial Recovery			

PAGE ____ OF ____

DRILLING LOG

Well/Boring Number Boring RT-2 (Tailings)

Project Richardson Flats Tailings

Project Number RP-8505-27

Date Started 8/2/85

Date Completed 8/2/85

Geologist Rob Smith / D Tweady

Driller — Dave's Drilling

Geophysical Logger ——

Permit Number ——

Property Owner Park City Mines, Inc.

LOCATION

N. ____

E. ____

Elevation 6600 ± 20

+	+ X
+	+

SE 1/4 of NE 1/4 of NE 1/4

Section 2 T 2S R 4E

County Summit State Utah

Drilling Method Air Rotary / Split Spoon Sampler

Samples Piezometer

Logs

Res. SP Gam. G-Den. Neut. Calip. Dev. Sonic

Rig Make and Model Chicago Pneumatic / CP-7000

Pipe dope used

Drill Bit Diameter 6" (2" split spoon)

DRILLING, CORING, BIT AND CASING RECORD

Diameter	Depth From	Depth To	Notes
6"	0	3.5	Oxidized
	3.5	12.5	Reduced
	12.5	14	Coarse Jig Tails
	16	17.7	Clay Sulfides
	17.7	22	Clay + Gravel

ADDITIVES USED

Depth From	Depth To	Additives

Notes: Four Splitspoon Samples taken
Hole in Tailings Pond
Grouted + Backfilled after Sampling
Wet at 12'

RICHARDSON FLATS

EPA ID# UT980952840

BORING RT-3

Depth Interval (feet) From	To	Description
0	0.75	CLAY: Pale reddish-brown, 5% sand, some pebbles and roots, (artificial fill).
0.75	3.7	FINE SAND-TAILINGS: Light olive gray to olive gray, straited, silt, damp to moist @ 2.5 feet.
3.7	7.3	SAND-TAILINGS: Dusky yellow, dry, to increasingly damp and wet @ 6 feet.
7.3	7.8	CLAY: Grayish brown, organic rich, stiff, some roots, moist, (original topsoil).
7.8	9.8	SILTY CLAY: Moderate yellowish brown, firm to stiff, softer in places from 8 to 9.8 feet.
9.8	11	CLAYEY SILT: Grayish-orange, firm to stiff, some white finely crystallive material (kaolinite?) in fractures and pockets, dry to damp.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 4.9 feet below ground surface on 2/2/99.

(3) Plug initial hole with bentonite chips. Direct push new hole to 7 feet. Set 5 feet of 0.010-inch factory-slotted screen from 7 feet to 2 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 1 feet. Bentonite chips to surface.

RICHARDSON FLATS
ID# UT980952840
BORING RT-4

Depth Interval (feet) From	To	Description
0	1	<u>CLAY</u>: Dusky yellowish brown, organic, soft, roots (artificial fill).
1	2.5	<u>SILT-TAILINGS</u>: Light olive gray.
2.5	5.2	<u>FINE SAND - TAILINGS</u>: Pale yellowish brown, well sorted, dry.
5.2	5.6	<u>FINE SAND AND SILT-TAILINGS</u>: Light brown to pale olive.
5.6	6.2	<u>SILTY CLAY</u>: Dusky brown, organic rich with roots (original top soil).
6.2	7.0	<u>SILTY CLAY</u>: Moderate yellowish brown to light brown, stiff, moist.
7.0	7.4	<u>SILTY CLAY</u>: Grayish-brown, organic rich, soft to firm, with roots, moist to damp.
7.4	8.0	<u>SILTY CLAY</u>: Moderate brown to light brown, stiff to very stiff.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Piezometer was found dry on 2/2/99.

(3) Set 5 feet of 0.010-inch factory slotted screen from 7 to 2 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 2 feet. Bentonite chips to surface.

RICHARDSON FLATS

ID# UT980952840

BORING RT-5

Depth Interval (feet) From	To	Description
0	0.7	SILTY CLAY: Dusky brown, organic rich, with roots, dry (artificial fill).
0.7	7.0	FINE SAND AND SILT - TAILINGS:Pale olive, dusky yellow, some coarse roots.
7.0	9.0	FINE SAND-TAILINGS: Pale green to dark yellowish brown, damp.
9.0	10.8	FINE SAND - TAILINGS: Medium gray, damp.
10.8	11.8	SILTY CLAY: Dark yellowish brown, organic rich, firm, abundant roots, damp, wet to saturated, (original top soil).
11.8	13	SILTY SAND: Brownish gray, soft, some clay, saturated.
13	14	SANDY CLAY: Greenish-orange, firm, wet, to moist @ 14 feet.
14	15	GRAVELY SAND: Pale reddish brown, compact, silty, damp to moist - not saturated.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 7.30 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 13 feet to 8 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from 13 feet to 7 feet. Bentonite chips to surface.

RICHARDSON FLATS

ID# UT980952840

BORING RT-6

Depth Interval (feet) From	To	Description
0	0.8	SILTY CLAY: Dusky brown, 5-10% sand, stiff, some roots (artificial fill).
0.8	1.1	CLAYEY SILT-TAILINGS: Light olive gray, soft to firm, damp.
1.1	2.0	FINE SAND-TAILINGS: Light olive gray, dry.
2.0	2.5	SILTY SAND-TAILINGS: Light olive gray, coarse roots, damp.
2.5	6.0	FINE SAND-TAILINGS: Light olive gray to dark yellowish orange.
6.0	14.4	FINE SAND AND SILT-TAILINGS: Medium dark gray, wet.
14.4	15.6	MEDIUM SAND-TAILINGS: Greenish-gray, loose, wet.
15.6	16.0	FINE SAND-TAILINGS: Light olive gray.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 4.87 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 10 to 5 feet; blank 1-inch diameter PVC casing to surface. Natural sand pack to 5 feet. Bentonite chips to surface.

RICHARSON FLATS

ID# UT980952840

BORING RT-7

Depth Interval (feet) From	To	Description
0	6	CLAY: Grayish black, organic rich, soft, spongy, abundant roots, saturated.
6	9.2	GRAVEL: Dark yellowish brown, silty, saturated.
9.2	10.5	GRAVELLY CLAY: Greenish-gray and moderate reddish brown, mottled, firm, damp to moist.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 0.0 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 6 feet to 1 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 1 foot. Bentonite chips to surface.

RICHARDSON FLATS

ID# UT980952840

BORING RT-8A/B SERIES

Depth Interval (feet) From	To	Description
0	1.2	CLAYEY SILT: Dark reddish brown, organic rich, <5% sand, dry to damp.
1.2	5.3	SILT: Light brown, with moderate orange pink mottling, some coarse roots, dry.
5.3	13.5	SILTY CLAY: Moderate brown, <5% coarse sand, stiff, increasing dampness below 5.3-feet some white material infilling fracture @7 ft; organic material @ 9.3 feet; pebbles @ 12.5 to 12.8 feet; increasingly moist and softer to 13.5, damp.
13.5	15.2	SANDY CLAY: Moderate brown to dark yellowish brown to clayey sand, dark yellowish brown fine sand @ 15.2 feet; 50% fine sand to fine gravel (quartzite and volcanic rock fragments); dry.
15.2	19	SILTY CLAY: Moderate brown, grayish brown organic material @ 16.6 feet, stiff, saturated; yields little free water from 16.6-16.9 feet; moist below 16.9 to 19 feet.
19	21.2	GRAVELLY CLAY: Moderate brown, 25-40% fine sand to fine gravel, moist to wet.
21.2	24	SILTY CLAY: Moderate brown to dark yellowish brown, stiff, w/ 5-10% fine gravel, firm to stiff, moist, moist to wet at 24 feet.
24	26	GRAVELLY CLAY-CLAYEY GRAVEL: Moderate brown, 40-50% fine sand to fine gravel, wet.
26	27	SILTY CLAY: Moderate yellowish brown, firm to stiff, moist.
27	30	SILTY CLAY: Moderate brown, 10-20% fine to coarse sand, soft, compacts easily, blockey.
30	31.7	GRAVELLY CLAY: Moderate brown, 10-20% fine to coarse sand, soft, compacts easily.
31.7	32	SILTY CLAY-CLAYEY SILT: Moderate yellowish brown, 5-10% fine to medium sand, firm to stiff, moist to wet.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 12.30 feet below ground surface in RT-8A; static water level at 12.23 feet below ground surface in RT-8B on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 31 to 26 feet in RT-8B; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from 26 to 25 feet; granular bentonite to surface.
Set 5 feet of 0.010-inch factory-slotted screen from 17 to 22 feet in RT-8A; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from 22 to 16 feet; granular bentonite to surface.

RICHARDSON FLATS

ID# UT980952840

BORING RT-9

Depth Interval (feet) From	To	Description
0	1.9	SILT: Dusky yellowish brown, organic rich, occasional pebble, dry.
1.9	2.3	SILT: Moderate brown, compact, dry.
2.3	6.0	FINE SAND: Dark yellowish orange, medium gravel, silty @ 5 feet, loose, dry.
6.0	9.6	GRAVELLY SILT: Moderate yellowish brown to moderate brown, 10-20% coarse sand to fine gravel, organic rich layer @ 6.6 feet, loose to firm, dry.
9.6	10.5	SILTY GRAVEL: Moderate yellowish brown, loose, dry.
10.5	11	GRAVEL: Very pale orange, coarse, dry.
11	13.2	GRAVELLY SILT: Moderate yellowish brown, silty gravel, medium sand to medium gravel.
13.2	15.4	GRAVELLY SILT: Moderate reddish brown to dark reddish brown, dry.
15.4	16.0	GRAVELLY SILT: Dark yellowish brown, loose, dry.
16.0	21.8	SILTY GRAVEL: Moderate yellowish brown, saturated and sandy at approximately 19.75 to 21.8, cobble @ 17 feet, then sharp contact and dry below.
21.8	23	GRAVEL: Moderate reddish brown, silty, clayey, moist.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 18.03 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 23 to 18 feet; blank 1-inch diameter PVC casing to surface. 10x20 sand pack from T.D. to 17 feet. Bentonite chips from 4 feet to ground surface.

RICHARDSON FLATTS

EPA ID# UT980952840

BORING RT-10

Depth Interval (feet) From	To	Description
0	2.1	CLAY: Black, organic rich, soft to firm, plastic, moist.
2.1	2.8	SILTY CLAY: Dusky yellowish brown, with 15% medium to coarse sand, firm, damp.
2.8	3.6	SANDY SILT: Dark yellowish brown to moderate yellowish brown, 25 to 40% fine sand, some clay, damp to moist.
3.6	6.3	SILTY SAND: Moderate yellowish brown, loose, well sorted, some coarse sand @ 6.3 feet, increasingly saturated with depth.
6.3	6.6	CLAY: Pale yellowish brown, firm plastic, wet.
6.6	8.0	SILTY SAND: Pale yellowish brown, loose, fine to medium sand, saturated.

NOTES:

(1) Color description corresponds to the Geological Society of America Rock Color Chart (1991).

(2) Static water level at 1.1 feet below ground surface on 2/2/99.

(3) Set 5 feet of 0.010-inch factory-slotted screen from 8 feet to 3 feet, blank 1-inch diameter PVC casing to surface. 10x20 sand pack from 3 to 2 feet; granular bentonite chips to surface.

ATTACHMENT NO. 2
X-RAY DIFFRACTION DATA

Analysis of Soil Samples/United Park City Mines Company

Prepared for: Weston Engineering, Inc.
P.O. Box 6037
Laramie, WY 82072
(307) 745-6118

Sample shipped from Park City, UT

Prepared by: Dr. Norbert Swoboda-Colberg
Dept. of Geology & Geophysics
University of Wyoming
P.O. Box 3006

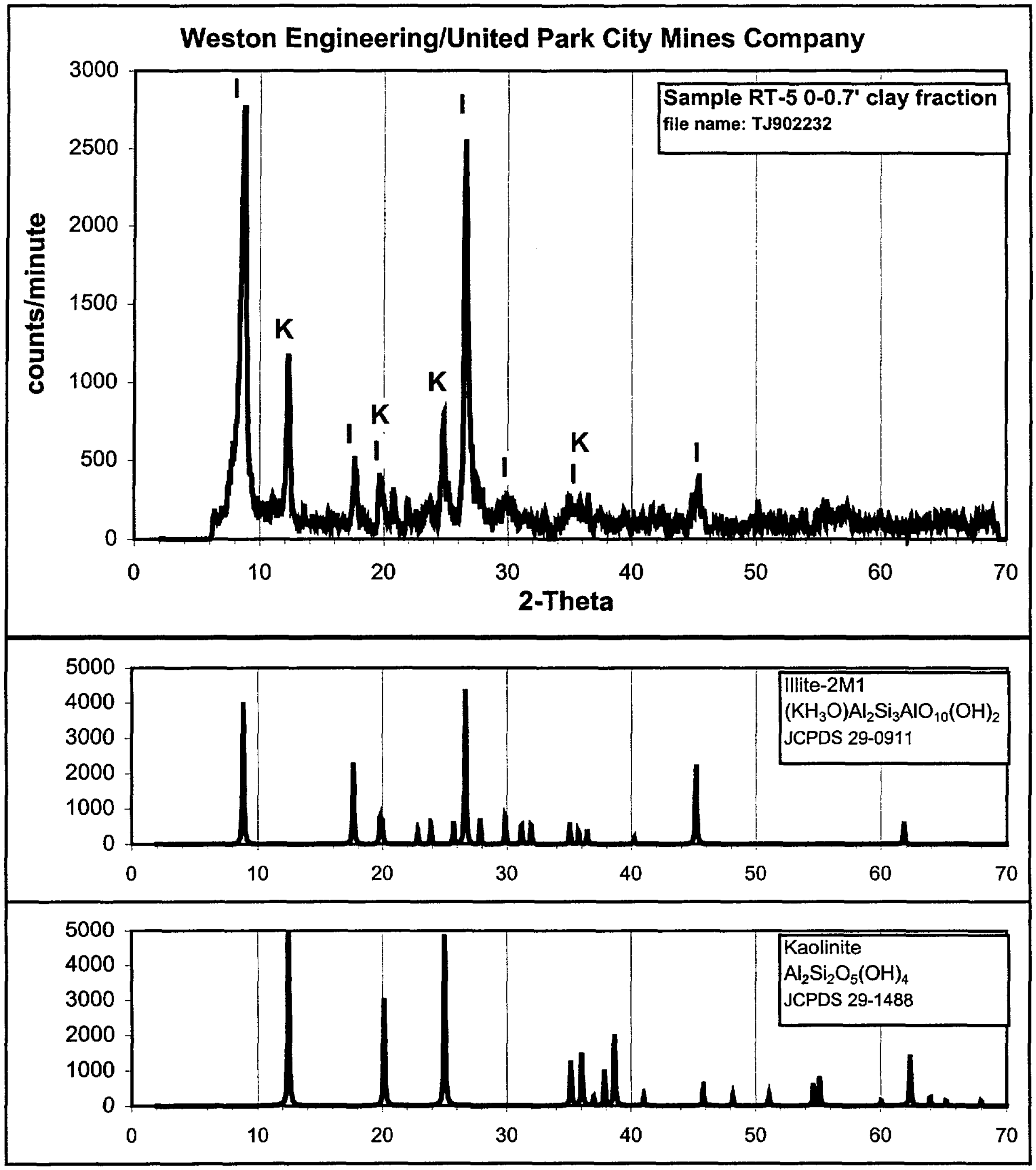
Samples: Boring RT-5, 0-0.7 feet
Boring RT-5, 11 feet
Boring RT-5, 13.5 feet
Sampled at Park City, UT on 2/15/99
Ref.: Bill Loughlin

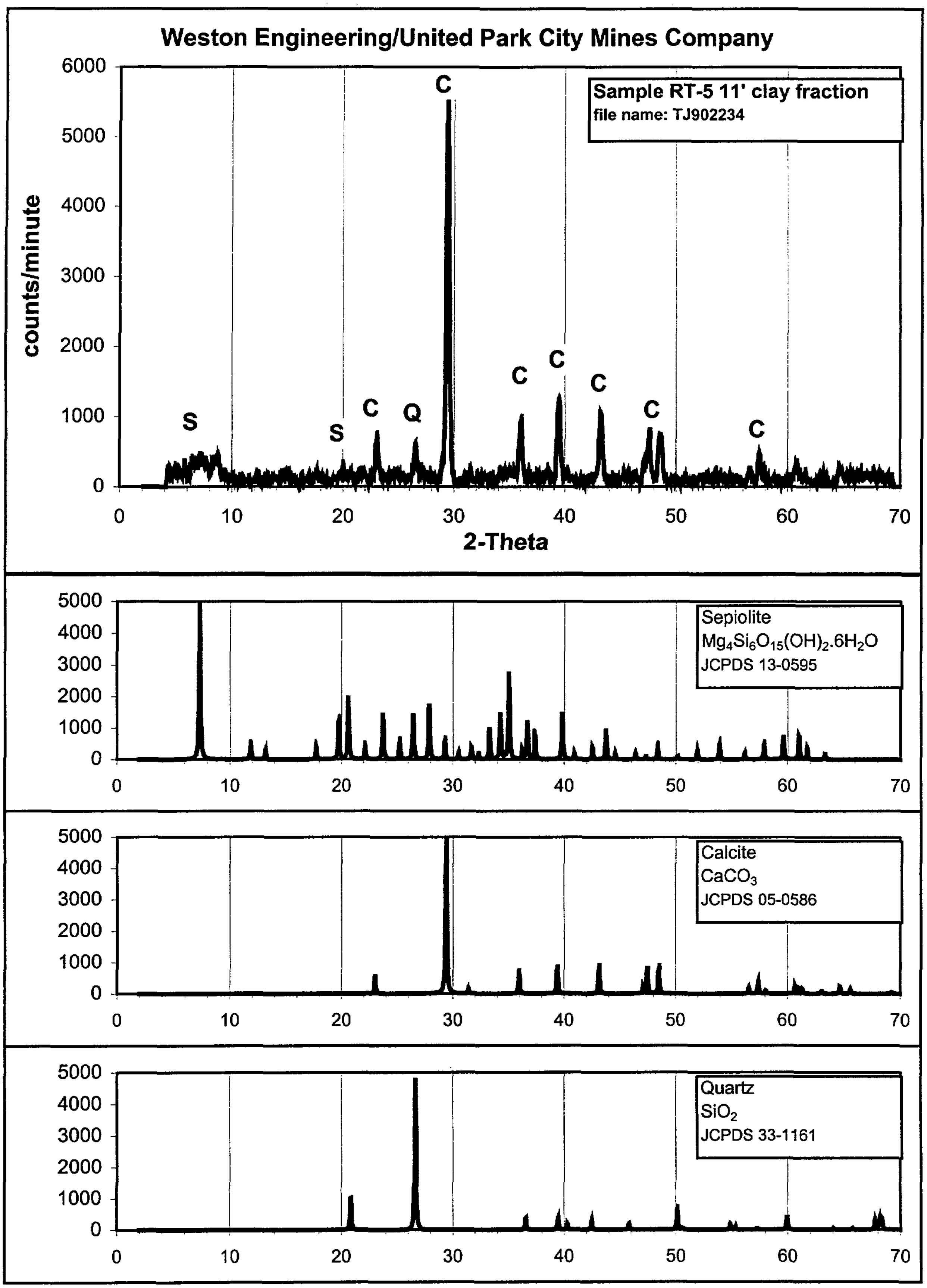
Sample Prep.: Samples were treated according to standard procedures for clay analyses in soils. Samples were treated with peroxide (removal of organic material) and size fractionated to enrich clay fraction.

Summary: The two deeper samples (11 and 13.5 feet) were visually very different; the sample from 11 feet depth was relatively organic rich soil, while the sample from 13.5 feet was mostly made up of clay and silt. However, the two samples are very similar in the composition of their clay fraction. In both samples the clay fraction consists of sepiolite, a magnesium silicate, and calcite (calcium carbonate).

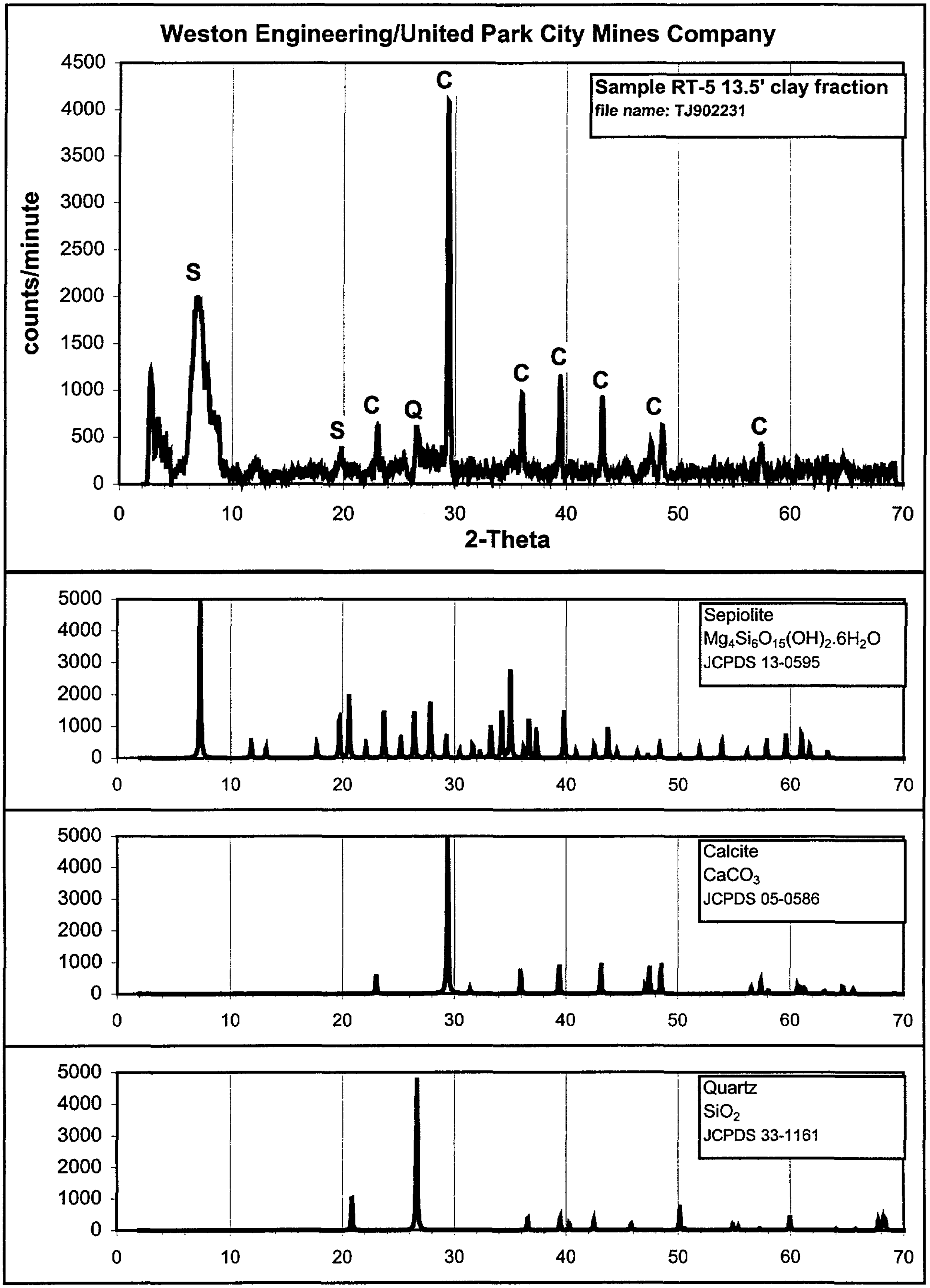
The surface sample (0-0.7 feet) has a clay composition which is completely different from that of the deeper samples. In the surface sample, the clay fraction is made up of illite (a potassium aluminum silicate) and kaolinite (an aluminum silicate).

Special Note: Sepiolite, the clay mineral identified in the deeper samples, is a relatively rare clay mineral and would not be expected to be found in the Park City area, although it is not entirely impossible. The characteristic peak at a d-spacing of 12Å does not match any other "simple" clay minerals. However, it is possible that the clay identified as "sepiolite" is in fact a rather ill-defined mixed-layer clay mineral (mixed mica and illite or smectite, for example) which can be found in relatively immature soils on granitic bedrock. The distinction cannot be made without further analysis.


Weston Engineering/United Park City Mines Company
Sample RT-5 0-0.7' clay fraction
file name: TJ902232
counts/minute
2-Theta
I
K
Illite-2M1
$(KH_3O)Al_2Si_3AlO_{10}(OH)_2$
JCPDS 29-0911
Kaolinite
$Al_2Si_2O_5(OH)_4$
JCPDS 29-1488



Weston Engineering/United Park City Mines Company
Sample RT-5 11' clay fraction
file name: TJ902234
counts/minute
2-Theta
S
S
C
Q
C
C
C
C
C
C
Sepiolite
$Mg_4Si_6O_{15}(OH)_2.6H_2O$
JCPDS 13-0595
Calcite
$CaCO_3$
JCPDS 05-0586
Quartz
SiO_2
JCPDS 33-1161



Weston Engineering/United Park City Mines Company
Sample RT-5 13.5' clay fraction
file name: TJ902231
counts/minute
2-Theta
S
C
Q
Sepiolite
$Mg_4Si_6O_{15}(OH)_2.6H_2O$
JCPDS 13-0595
Calcite
$CaCO_3$
JCPDS 05-0586
Quartz
SiO_2
JCPDS 33-1161

ATTACHMENT NO. 3
ARTIFICIAL FILL CAP PERMEABILITY DATA

Applied Geotechnical Engineering Consultants, Inc.

January 12, 1999

Confidential and Privileged: Attorney-Client and Work Product Privilege

LeBoeuf, Lamb, Greene & MacRae, L.L.P.
100 Kearns Building
136 South Main Street
Salt Lake City, UT 84101

Attention: Brad Merrill

Subject: Permeability Testing
United Park City Mines/Richardson Flats Property
Summit County, Utah
Project No. 983806

Gentlemen:

Applied Geotechnical Engineering Consultants, Inc. was requested to test the soil for classification and permeability on the Richardson Flats property in Summit County, Utah.

FIELD SAMPLING

On December 2, 1998, a representative of AGEC visited the site and tested the soil in its in situ condition for moisture content and dry density. Listed below is a summary of the approximate locations and the in-place moisture content and dry density:

Location No.	Location	Moisture Content (%)	Dry Density (pcf)
1	Main Embankment West	27.5	87.7
2	West Central	26.7	88.7
3	North Central	27.7	88.5

Samples were obtained of the soil immediately beneath the area tested for moisture content and density. These samples were returned to the laboratory for classification testing. The samples are classified as lean clay with sand. The laboratory test results are summarized on Figures 1, 2 and 3.

600 West Sandy Parkway • Sandy, Utah 84070 • (801) 566-6399 • FAX (801) 566-6493

PERMEABILITY TESTING

Two of the samples were remolded in the laboratory to their in-place moisture content and density. The samples were then tested in a triaxial permeameter to determine the permeability. Listed below is a summary of the laboratory test results:

Sample No.	Sample Location	Permeability (cm/sec)
2	West Central	7×10^{-8}
3	North Central	3×10^{-8}

These two samples were tested with the anticipation that they would provide the boundaries of the highest and lowest of the three samples obtained.

If you have any questions or if we can be of further service, please call.

Sincerely,

APPLIED GEOTECHNICAL ENGINEERING CONSULTANTS, INC.

James E. Nordquist, P.E.

JEN/js

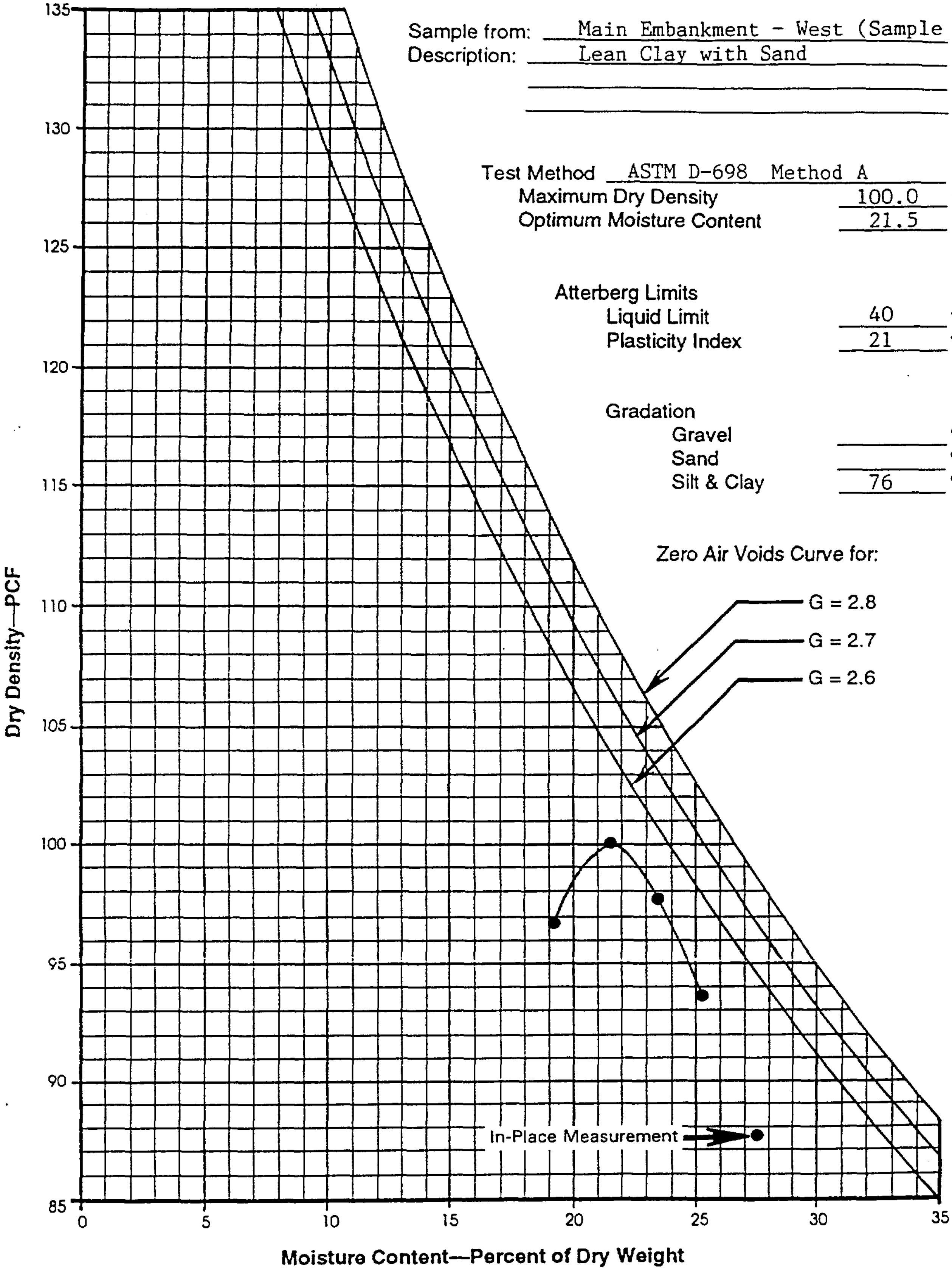
Applied Geotechnical Engineering Consultants, Inc.

Sample from: Main Embankment - West (Sample #1)
Description: Lean Clay with Sand

Test Method ASTM D-698 Method A
Maximum Dry Density 100.0 pcf
Optimum Moisture Content 21.5 %

Atterberg Limits
Liquid Limit 40 %
Plasticity Index 21 %

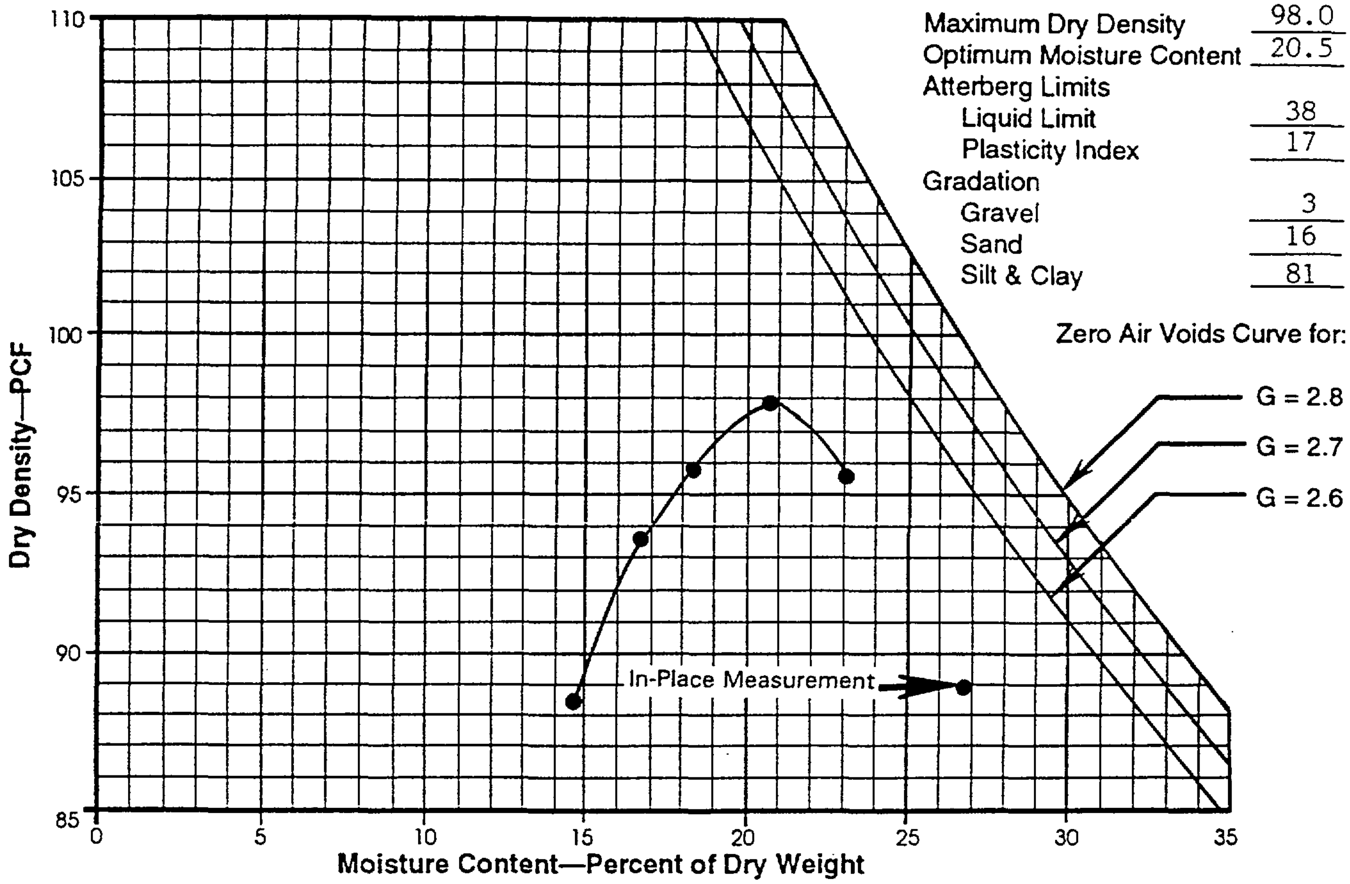
Gradation
Gravel %
Sand %
Silt & Clay 76 %



Project No. 983806 **COMPACTION TEST RESULTS** Figure 1

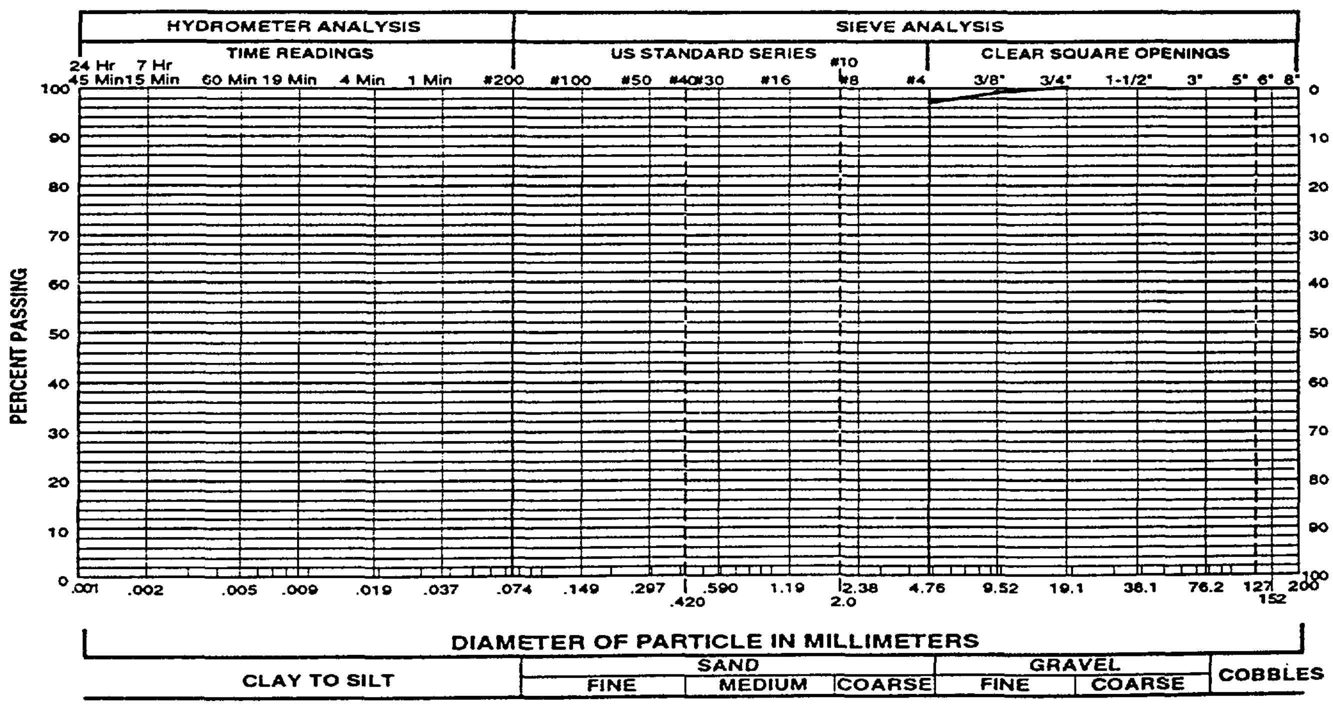
Applied Geotechnical Engineering Consultants, Inc.

Maximum Dry Density	98.0	pcf
Optimum Moisture Content	20.5	%
Atterberg Limits		
Liquid Limit	38	%
Plasticity Index	17	%
Gradation		
Gravel	3	%
Sand	16	%
Silt & Clay	81	%



Compaction Test Procedure ASTM D-698 Method A

Sample of: Lean Clay with Sand From: West Central (Sample #2)



Project No. 983806

GRADATION & COMPACTION TEST RESULTS

Figure 2

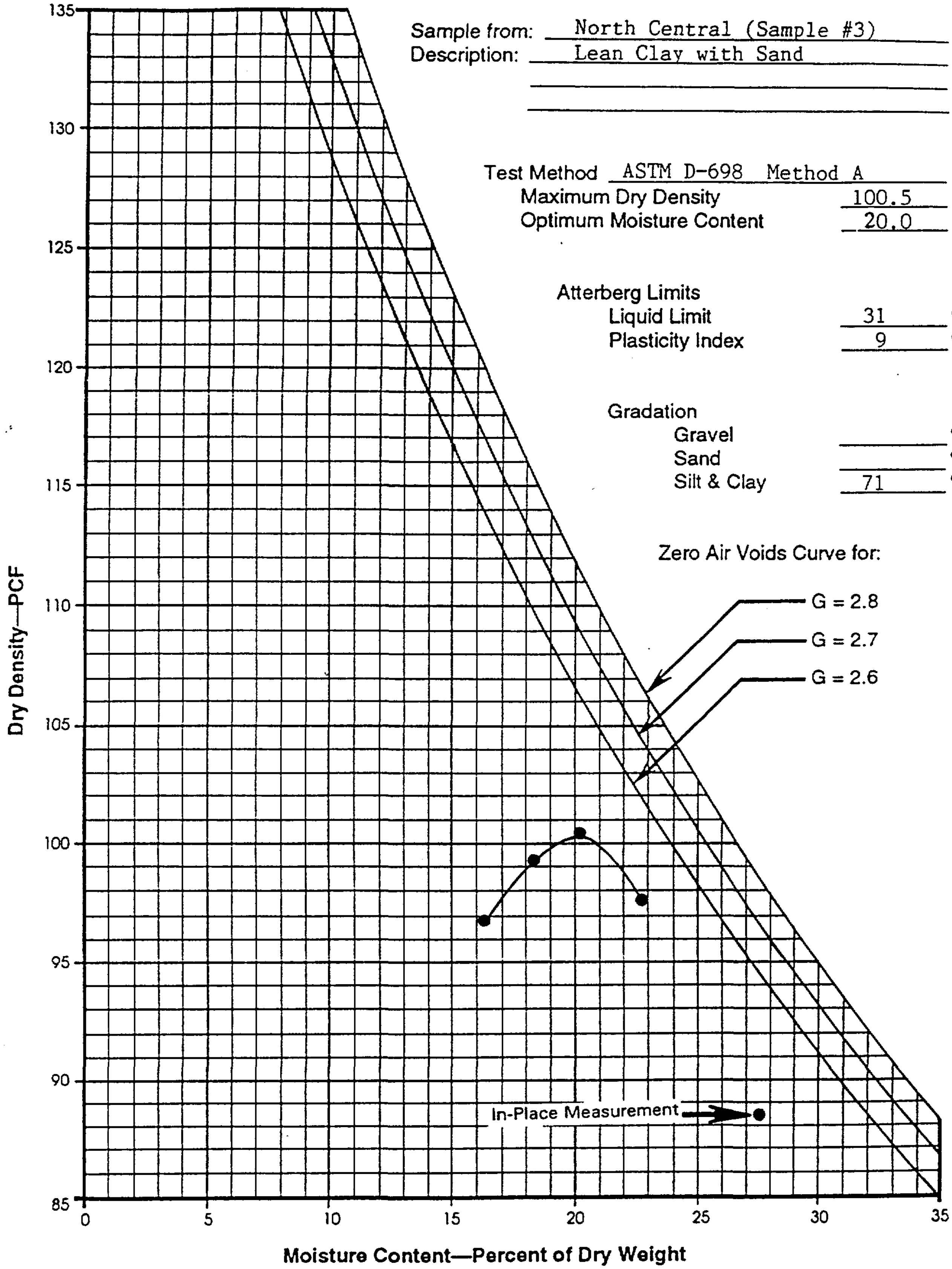
Applied Geotechnical Engineering Consultants, Inc.

Sample from: North Central (Sample #3)
Description: Lean Clay with Sand

Test Method ASTM D-698 Method A
Maximum Dry Density 100.5 pcf
Optimum Moisture Content 20.0 %

Atterberg Limits
Liquid Limit 31 %
Plasticity Index 9 %

Gradation
Gravel ____ %
Sand ____ %
Silt & Clay 71 %



Project No. 983806 **COMPACTION TEST RESULTS** Figure 3

EPA REGION VIII
SUPERFUND DOCUMENT MANAGEMENT SYSTEM

DOC ID # 483988

IMAGERY COVER SHEET
UNSCANNABLE ITEM(S)

Contact the Superfund Records Center to view this (these) document(s).
(303-312-6473)

SITE NAME: Richardson Flat Tailings

REPORT OR DOCUMENT TITLE: Preliminary RI/FS workplan draft for Richardson Flat Tailings site

DATE OF DOCUMENT: 1/26/99

DESCRIPTION: oversized map

APPENDIX B: EPA Final Report, March 1993

FINAL REPORT
RICHARDSON FLATS TAILINGS
SUMMIT COUNTY, UTAH
TDD #T08-9204-015 and #T08-9210-050
PAN EUT0039SBA and EUT0039SDA

PREPARED FOR:

U.S. Environmental Protection Agency
Region VIII
Waste Management Division
Mike Zimmerman, On-Scene Coordinator

PREPARED BY:

7

Scott Keen
Ecology and Environment, Inc.
Technical Assistance Team

DATE SUBMITTED: February 19, 1993

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RICHARDSON FLATS TAILINGS SITE
TDD #T08-9204-015 and #T08-9210-050
PAN EUT0039SBA and EUT0039SDA

1.0 INTRODUCTION AND PURPOSE

This report is written to satisfy the requirements of Technical Direction Documents (TDDs) #T08-9204-015 and T08-9210-050 issued to to the Ecology and Environment, Inc. Technical Assistance Team (E & E-TAT) by the Region VIII U.S. Environmental Protection Agency (USEPA) Emergency Response Branch (ERB). This work was begun in April 1992. Other reports submitted by the TAT under this TDD include: "Trip Report, Richardson Flats Tailings Site, August 17, 1992"; and "Inspection of the Tailings Dam at Richardson Flats, Memorandum to EPA-OSC", August 6, 1992. Within this same time frame the TAT has also performed work relevant to the site under three separate TDDs (T08-9204-041, T08-9207-019 and T08-9210-041). Reports/documents generated by the TAT as a result of these three TDDs are: the "Report of Drilling Activities, Richardson Flats Tailings Site, July 13, 1992"; "Response to PRPs September 10, 1992 Memorandum Regarding Well Installation Activities, Memorandum to EPA/OSC, September 11, 1992"; and "Report of Sampling Activities, January 4, 1993".

Also relevant to this work is the report entitled "Air Sampling and Analysis, Final Report", August 1992, prepared by the Environmental Response Team (ERT) of the USEPA.

The Richardson Flats Tailings site is located three and one-half miles northeast of Park City, Summit County, Utah. On approximately 160 acres from 1975 through 1981 mine tailings were placed by slurry pipeline from mines owned by United Park City Mines (UPCM). A small portion of the site was also used for a municipal/sanitary landfill during the mid-1970s.

The Richardson Flats Tailings site appeared in the Federal Register on February 7, 1992 as a proposed National Priorities List (NPL) site. Because of this proposed listing the USEPA/ERB became responsible for assuring immediate site safety for the interim period following proposed listing through the initiation of remedial activities. The purpose of this work has thus been to examine the site in terms of immediate threats to human health or the environment. This report is a summary of findings to that end.

2.0 SUMMARY AND RECOMMENDATIONS

Four areas of concern at the Richardson Flats Tailings site have been examined to determine immediate threats to human health or the environment. These four areas are: 1. the airborne release of contaminants; 2. the release of contaminants from the tailings area; 3. the release of contaminants from the municipal/sanitary landfill area; and 4. site access. In general, the site presents little or no immediate threat to human health or the environment. Following is a summary of specific findings and specific recommendations to assure site safety in the interim period preceding remedial activities.

Findings

- Airborne releases of metal contaminants from the tailings area have been minimized and do not pose an immediate threat.

- Existing soil and salt grass cover over the tailings area are providing adequate dust suppressing capability to prevent an immediate threat of airborne contaminant releases. For the long term however, soil cover is sparse and salt grass may disappear as the site becomes drier. In the long term, dusty conditions may recur.

- Soil being used by UPCM for tailings cover does not contain contaminants at concentrations that pose an immediate threat to human health or the environment.

- There is no immediate threat of gross failure of the tailings containment structure. There is seepage, however, through and/or around the dam end of the structure. In the summer of 1992, a hillside diversion ditch on the north perimeter of the tailings area had also been cut off from the main drainage ditch. This could permit runoff into the tailings area.

- During the period of this assessment, surface water flow and runoff from the tailings area was very low. Almost no contaminants attributed to the site could be documented entering local surface water. The exception was the documentation of a release of lead (151 μg/l) to Silver Creek from the site. Although this release is a very important finding, it is not considered an immediate threat to human health and the environment. This release would be better addressed by a comprehensive remedial plan rather than by emergency response actions.

- The placement of tailings has contributed to a significant rise in total dissolved solids (TDS) of shallow groundwater. Concentrations of individual metal contaminants do not increase to significant levels within shallow groundwater near the tailings area.

- Sediment in the "wetlands" area of the site between Silver Creek and the base of the tailings dam is severely contaminated with tailings material and the associated high levels of metals (arsenic, cadmium, lead, ...). Because this area is six to eight feet above Silver Creek and surface water flow through it is from the diversion ditch and from seepage through the tailings containment structure, this sediment contamination appears directly attributable to the site. Although this is a very significant finding, contaminated sediment is relatively immobile and the result of a long term process. It is not considered an immediate threat and would be better addressed by a comprehensive remedial plan rather than by emergency response actions.

- In the area of the municipal/sanitary landfill, no organic or inorganic contaminants that could be attributed to the site were detected in surface water.

- Shallow groundwater in the area of the municipal/sanitary landfill showed no organic contaminants attributed to the site; however, TDS and arsenic concentrations do show increases which are attributed to the site.

- Site access has been satisfactorily limited by a security fence surrounding the site.

Recommendations

- Although serious environmental concerns have been documented at the Richardson Flats Tailings site, this report does not recommend that any of these concerns be addressed with emergency response actions as immediate threats to human health or the environment. The concerns of surface water, groundwater, and sediment contamination and potential airborne releases of metals documented by this and other studies are problems which have existed for many years. The severity of these problems will not increase dramatically but will persist at a steady level. This report recommends that all concerns at the Richardson Flats Tailings site be addressed through the comprehensive remedial planning process which NPL sites are subject to. The body of this report should clarify some of the site concerns and should assist in developing the remedial plans.

3.0 SITE ACTIVITIES

Following an initial site visit in April 1992, the TAT prepared a work plan to assess contaminant releases to groundwater, surface water, and to the local environment via the air pathway. Contaminants of concern include metals from the tailings area and the landfill area, and several types of potential organic contaminants from the landfill area.

Additional monitoring wells were installed at the site during the week of June 22, 1992. Air monitoring was conducted by the ERT on June 10 and 11, 1992. During the week of August 3, 1992 the TAT was on-site for several activities including groundwater and surface water sampling, determination of depth of cover on the tailings area, sampling of cover soil material, and inspection of the tailings containment structure and diversion ditch system. Additional groundwater sampling occurred during the week of November 9, 1992.

4.0 RESULTS AND FINDINGS

? July "86" Data

4.1 AIR MONITORING

In July 1986 air monitoring documented the airborne release of arsenic, cadmium, lead, and zinc in particulate form from the Richardson Flats Tailings site. Since that time UPCM has placed cover soil over approximately 85% (UPCM's estimate) of the tailings area. On June 10 and 11, 1992 air samples were again collected to assess the airborne release of these four metals. At 5 sampling locations on the site's perimeter boundary 17 air samples were collected. The sampling procedure and analytical results are contained in their entirety in the Air Sampling and Analysis, Final Report, Richardson Flats, August 1992, prepared by the USEPA/ERT. In summary, these air monitoring activities showed no detectable levels of cadmium, lead, or arsenic in any samples. Trace levels of zinc (at the level of quantitation) were detected in four samples only. No samples on any day under any wind condition exhibited elevated levels of contaminants. Restriction from site access precluded the implementation of the optimum sampling strategy; however a conclusion can still be made that airborne releases of contaminants from the Richardson Flats Tailings site are not posing an immediate threat to human health or the environment.

4.2 TAILINGS ASSESSMENT

4.2.1 DEPTH OF COVER

Depth of cover was determined at 29 locations over the tailings area. These locations are depicted on Figure 2. Locations were determined by first establishing a reference line in an approximate direction of northwest to southeast through the tailings area (Figure 1). This reference line includes and is a continuation of a straight portion of the tailings containment structure as shown in Figure 1. Points were marked along this reference line at 200 or 400 foot intervals. At 2800 feet from the base point a second reference line was established in a perpendicular direction to the first reference line. This second reference line extended in an approximate direction from southwest to northeast. For the purpose of sampling or soil cover measurements, all locations within the tailings area were identified relative to these two reference lines. For example, a sample location identified as 1900, 800L would be 1900 feet from the base point (using the first reference line) and 800 feet to the left (northeast) using the second reference line.

Sample locations were on an approximate grid pattern of 400 feet x 400 feet. The grid covered most of the tailings area. Table 1 presents the results of cover depth measurements. At all but one location a distinct line could be seen between soil cover and gray colored tailings beneath the cover. X-ray fluorescence (XRF) measurements for lead were taken to confirm the visual determination of cover depth or to determine cover depth where a distinct line was not visible. As seen in Table 1, much of the tailings area is covered with a salt grass. This is a native grass which appeared to form an excellent cover on the tailings. Where the salt grass is present no soil cover had been placed over the tailings; however roots of the grass extended five to six inches below ground surface, and the roots and the grass itself formed an effective dust suppressing mat on top of tailings material.

The grid pattern shown in Figure 2 represent much of the entire tailings area. Of the 29 points on this grid only 1 point had no cover soil and no salt grass present. Nine of the 29 points (approximately 30 percent) had no cover soil present. At the 20 points where cover soil was present, the cover soil was 6 inches thick or less at 6 points and greater than 6 inches in thickness at 14 points.

It is important to note that the salt grass which became established on the tailings area is likely dependent upon a moist environment for survival. This grass became established when tailings were slurried to the site creating periods of standing water. The grass may slowly disappear, and its extensive root system may make conditions difficult for other plants to become established.

UPCM has expressed intentions of adding soil cover to that small portion of the site which currently has no soil cover or where salt grass is not established. When this is completed, the tailings area will have adequate cover to prevent an immediate threat of excessive dust. Much of the existing soil cover, however, is sparse (less than six inches in thickness); and much of the area is covered with a salt grass that may disappear as the site becomes drier. Dusty conditions could recur in the future if proper soil cover over the entire tailings area is not applied.

4.2.2 COVER SOIL ANALYSES

Figure 2 shows the location of six soil samples collected on August 6, 1992. Each of these samples, except sample RF-SO-3, was taken from soil that was added by UPCM as cover to the site. Table 2 contains analytical results for these samples and the normal ranges for these elements in soils of the western United States. Sample RF-SO-3 was collected within an area covered by salt grass. As discussed, where salt grass is currently established soil cover has not been added by UPCM. This soil sample is more likely to be representative of tailings material.

As Table 2 shows, constituents of soil cover do not consistently fall into the normal ranges for all elements. In soil cover samples, however, no contaminant is grossly out of line from the normal ranges presented in Table 2. Results for sample RF-SO-03 show very high concentrations of antimony, arsenic, cadmium, copper, lead, mercury, selenium, and zinc; however this sample is tailings, not cover material. It appears that soil being used for cover material by UPCM does not contain contaminants at concentrations that would pose an immediate threat to human health or the environment.

4.2.3 TAILINGS CONTAINMENT

On August 4, 1992 the TAT inspected the tailings containment structure. This inspection did not include trenching or boring into the embankment and thus was not a full assessment of the structure. Results of this inspection were summarized in a memorandum to the OSC dated August 8, 1992. This memo is included with this report as Appendix A. Important findings of this inspection follow.

1. Main Embankment.
   The main embankment is oversteep lying at 1.0:1.0 to 1.5:1.0 (run:rise). Approximately six inches of fine dry sand, possibly windblown tailings, were noted under a three inch topsoil cover layer on the downstream face of the embankment. The sand has no strength and will erode quickly if exposed. A 35% to 50% grass cover was on most of the embankment which will help in erosion control. No cracking was evident on the embankment, although the sand layer would tend to hide any small cracking. Also, no bending (bulging) was noted on the embankment.

2. Toe of the Main Embankment.
   Rank vegetation, in the form of willows and trees, is growing at the toe of the dam. Approximately eight inches of loamy damp soil is evident on the toe of the dam. The amount of vegetation and the type of soils on the toe of the dam indicate that the area receives a lot of water. As wet soils were noted approximately six to eight feet above the stream level this water is probably due to seepage under the dam. Other evidence of seepage from the toe of the dam was evident in the forms of; soft marshy areas, rank vegetation including willows, loamy soils, damp soils, and areas where water had been standing (although no standing water was observed on August 4, 1992).

3. The North Abutment.
   A swampy, loamy area on the north abutment, adjacent to where the embankment meets the abutment, was noted. The area was well above the toe of the dam at the location of the north monitoring well. This well recharged quickly when bailed. These conditions indicate that water seeps around or through the contact between the abutment and the embankment. Under full head conditions (saturated tailings) this would be an area where failure of the embankment could occur.

4. Crest of the Main Embankment.
   The crest is sloped back toward the tailings area allowing any water to drain back to the tailings pond. However, small erosional gullies are forming on the crest and downstream face of the dam and could eventually lead to larger gullying on the dam.

5. Water Flow.
   Water elevations behind the embankment are unknown, however the elevation of water in the ditch and the pond south of the tailings area are probably indicative of the elevation of

groundwater behind the embankment. From the information available in the Dames & Moore, Inc. reports, it is unlikely that a cutoff wall was installed around the perimeter of the pond to control seepage under either the embankment or the dike. The piezometer located on the toe of the dam indicated the water level to be five feet below ground surface. The swampy ground and recharge rate of the monitoring well on the north abutment indicates that water flow from some source is occurring. Inspection of the road cut north of the abutment revealed no seeps. Without further investigation it is conservative to use a worst case scenario and assume that the source of the seep is the water in the tailings behind the dam and that the abutment/embankment contact is a drainage path for the water.

6. Perimeter Dike.
   The perimeter dike was probably constructed by stripping materials off of the downstream side and piling the undifferentiated material up as a dike. The slopes are approximately 2.0:1.0. The dike is used as the access road for the pond and its elevation varies from two to five feet above the level of the tailings in the pond. The dike appears to be in good condition.

7. Diversion Ditch.
   A diversion ditch has been constructed along the perimeter of the tailings pond as designed by Dames & Moore, Inc. The ditch depth and width varies, generally getting deeper and wider as it progresses downstream. Standing water was evident in most of the ditch on the southern perimeter of the property. Rushes, sedges, and cattails wee growing in the bottom of the ditch along the entire length. Recent work has been performed by the owners in flattening the ditch banks and adding topsoil to the banks. This work is approximately one-half completed. According to the owners, the rest of the ditch is to be similarly regraded and topsoiled. At the time TAT inspected the site, the hillside diversion ditch, on the north perimeter of the tailings pond, had been cut off from the main ditch as a result of topsoil stripping. This important feature should be reconnected to the main ditch as soon as possible to prevent additional water flowing into the tailings pond.

In conclusion, based on the observed conditions of the tailings containment or embankment structure and the relatively dry condition of the tailings, there is no immediate threat of gross failure of this structure. Of more immediate concern are: seepage from the toe of the dam evidenced by wet/saturated soil well above stream level; seepage around or through the contact between the abutment and the embankment near the location of the northernmost groundwater monitoring well; and the hillside diversion ditch located on the north perimeter of the tailings area which has been cut off from the main drainage ditch by topsoil stripping activities allowing runoff into the tailings area.

Recommendations include keeping the tailings area dry through the maintenance of the diversion ditches. The connection between the hillside diversion ditch and the perimeter diversion ditch should be restored.

4.2.4 SURFACE WATER

Surface water samples collected for assessment of the tailings area are shown on Figure 1. These eight sample numbers are RF-SW-01 through RF-SW-08. Inorganic analytical results for surface water samples are presented in Table 3. Within Silver Creek samples RF-SW-01 through RF-SW-04 are considered upgradient of the tailings area and samples RF-SW-05 and RF-SW-06 are downgradient. In comparing upgradient sample results with downgradient sample results very few significant differences are noted. Lead increases by a factor of 5.7 in sample RF-SW-05 when compared to the average lead concentration of the four upgradient samples. In sample RF-SW-06 arsenic increases by a factor of 2.1 and silver increases by a factor of 4.2 when compared to the average concentration of the four upgradient samples.

It is important to realize that within surface water most metals will be quickly oxidized, precipitate, and tend to settle out of the bulk water and became incorporated into stream sediment. Thus, metals in surface water generally are transported in particulate/suspended form. In a very low flow period of the year (August), when surface water is not turbulent, metals are not transported to the extent that they are transported during higher flow conditions.

The Utah Code, 26-11-2 through 20, has classified the Weber River from the Stoddard diversion to the headwaters (including Silver Creek) in the following manner: IC-protected for domestic purposes with prior treatment by treatment processes as required by the Utah Department of Health; 3A-protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain; and 4-protected for agricultural uses including irrigation of crops and stock watering. The Utah Code establishes specific numeric criteria for contaminants based upon use classification.

Applicable inorganic standards from the State Code are summarized in Table 4. The Utah Code prohibits discharges or placement of wastes in such a manner that will cause violations of these numerical standards. The State has designated Silver Creek to be in three use classes (1C, 3A, and 4). For the domestic source class (1C) upgradient samples from Silver Creek meet all standards. The two downgradient Silver Creek samples meet all standards except for lead in sample RF-GW-05. The data indicates that during this sampling event a violation of the lead standard for the State Domestic Source (1C) surface water class was caused by discharges from the Richardson Flat tailings site. For the Agricultural Class (4) the data also indicates a violation of the lead standard in sample RF-SW-05.

State standards for Class 3A Surface Waters, protected for cold water species of game fish and other cold water aquatic life, including the necessary aquatic organisms in their food chain, are divided into four day average (chronic) standards and one hour average (acute) standards. Grab samples collected during the week of August 4, 1992 could only be compared to the acute standards. This comparison shows that upgradient and downgradient samples from Silver Creek meet all Class 3A standards, except those standards for lead and zinc which are exceeded in both upgradient and downgradient samples.

The State Code also contains numeric standards for surface waters for the protection of human health. Those applicable inorganic standards are also presented in Table 4. All upgradient and downgradient samples from Silver Creek meet the human health standards for antimony, cadmium, chromium, copper, silver, selenium, and zinc. Both upgradient and downgradient samples fail to meet human health standards for arsenic and beryllium. One upgradient sample, RF-SW-02, does not meet the human health criteria for nickel. One downgradient sample, RF-SW-05, does not meet the human health standard for lead.

What is important to this report when examining inorganic analytical data for Silver Creek and when considering the several state standards for the protection of surface waters? The detection of lead in one downgradient sample at 151 µg/l is likely the most significant observation. This lead level and the relatively low lead concentration in the four upgradient samples constitutes a violation of the State Code for protection of Class 1C and Class 4 surface waters. Sample RF-SW-05 also demonstrates a violation of the state standard for protection of human health. This sample may help to confirm the findings of earlier studies or highlight an area of concern for later remedial activities. In the context of this project, however, this observation of an elevated lead level in one of two downgradient surface water samples cannot be seen as posing an immediate threat to human health or the environment. A "release" has been documented, however the documentation of an ongoing event is sparse.

4.2.5 GROUNDWATER

One upgradient and two downgradient monitoring wells (Figure 1) were sampled during the week of August 4, 1992. Results of inorganic analyses are presented in Table 6. Sample RF-GW-04 is from the upgradient well; samples RF-GW-05 and RF-GW-09 are from two wells at the base of the tailings dam.

Calculation of total dissolved solids (TDS) level of the upgradient well shows upgradient groundwater to contain less than 500 parts per million (ppm) TDS. This finding is consistent with upgradient TDS concentrations found during previous sampling activities in August 1985.

State of Utah Wastewater Disposal Regulations, Part II, Standards of Quality for Waters of the State establishes classes of groundwater. If only filtered samples are considered, upgradient groundwater would be classified 1A, Pristine Groundwater. If unfiltered samples are evaluated, upgradient groundwater would be classified III, Limited Use Groundwater. State regulations also establish protection criteria which prohibit discharges to groundwater that would cause violations of the numeric groundwater quality standards.

Comparison of upgradient versus downgradient water quality from Table 6 shows that no individual contaminants increase to concentrations that would cause violations of either Class 1A or Class III groundwater protection standards. TDS levels, however, show increases (downgradient versus upgradient) well in excess of the protection standards for either Class 1A or Class III groundwaters. This increase in TDS of groundwater is attributed to the influence of tailings material on water chemistry and constitutes a violation of state regulations pertaining to the protection of groundwater quality.

4.2.6 SEDIMENT

Figure 1 shows a "wetlands" area between the base of the tailings dam and Silver Creek. Within this area four sediment samples were collected. Results of inorganic analyses of these samples is presented in Table 7 along with the normal ranges of elemental concentrations in soils of the western United States.

Analytical results show the following. Antimony is present at levels 39 to 98 times higher than the normal maximum concentration in soils of the western United States. Arsenic is present at levels 11 to 28 times higher than the normal maximum concentration in soils of the western United States. Cadmium is present at levels 75 to 210 times higher than the normal maximum concentration in soils of the western United States. Lead is present at levels 75 to 210 times higher than the normal maximum concentration in soils of the western United States. Mercury is present at levels 11 to 74 times higher than the normal maximum concentration in soils of the western United States. Selenium is present at levels 17 to 76 times higher than the normal maximum concentration in soils of the western United States. Zinc is present at levels 55 to 410 times higher than the normal maximum concentration in soils of the western United States.

Water flow through the wetlands area is now primarily from the diversion ditch. Some seepage from the tailings area through or around the containment structure may also influence flow and/or chemistry of this wetlands (See Report Section on Tailings Containment). Flow is toward Silver Creek, and this badly contaminated sediment appears to be tailings material that is being transported from the site.

In Table 2, Inorganic Analytical Results for Soil, sample RF-SO-03 was a sample of tailings material. This tailings sample showed the following ratio of six elements: arsenic (4.3); cadmium (1); calcium (713); iron (811); lead (70); and zinc (120). In Table 7, Inorganic Analytical Results for Sediment, the four sediment samples plus one duplicate, when averaged, show the following ratio of the same six elements: arsenic (3.1); cadmium (1); calcium (904); iron (805); lead (72); and zinc (162). These ratios of elements are very similar and likely indicate that sediment in the wetlands area is tailings material from the site.

4.3 LANDFILL ASSESSMENT

4.3.1 GROUNDWATER

. Three monitoring wells were installed in the area of the landfill during the week of June 22, 1992. These wells were sampled during the week of November 9, 1992. Sample locations are shown on Figure 1. Results of inorganic analyses are presented in Table 8. This table also contains results from a rinsate blank taken during sample collection and, for reference, results from RF-MW-04, a distant background monitoring well.

As shown in Figure 1, the three monitoring wells (1, 2 and 3) in the area of the municipal/sanitary landfill roughly surround the landfill. Analytical results confirm that sample location RF-MW-01 is hydraulically upgradient to sample locations RF-MW-02 and RF-MW-03. Estimates of total dissolved solids (TDS) for this upgradient monitoring well show that upgradient groundwater TDS is well below 500 ppm. Based on the inorganic analytical results of Table 8 and a TDS value of less than 500 ppm, groundwater immediately upgradient of the landfill is classified as Class 1A, Pristine Groundwater, by the State of Utah Groundwater Quality Standards.

State protection levels for Class 1A groundwaters are very rigid. Utah standards include the following requirements for Class 1A groundwaters.

1. TDS may not increase above 1.1 times the background value.
2. In no case will the TDS increase above 500 ppm.
3. When a contaminant is present in a detectable amount as a background concentration, the concentration of the pollutant may not exceed 1.1 times the background concentration or exceed 0.1 times the groundwater quality standard whichever is greater.
4. When a contaminant is not present in a detectable amount as a background concentration, the concentration of the pollutant may not exceed 0.1 times the groundwater quality standard value, or exceed the limit of detection whichever is greater.
5. In no case will the concentration of a pollutant be allowed to exceed the groundwater quality standard.

Comparison of the background sample, RF-MW-01, with the two downgradient sample locations, RF-MW-02 and RF-MW-03, shows the following.

1. TDS levels in groundwater increase in downgradient locations to concentrations above 500 ppm.
2. Of specific inorganic contaminants, arsenic shows the most significant increase in concentration from upgradient to downgradient samples. Arsenic was below 5.0 ppb or undetected in the upgradient sample (RF-GW-01). Dissolved arsenic was 24 ppb in RF-MW-02 and 59 and 70 ppb in two samples from RF-GW-03. The state groundwater quality standard for arsenic is 50 ppb. This is a clear violation of state groundwater

protection requirements which can be attributed to the landfill.

The groundwater samples taken from the area of the landfill were also analyzed for organic contaminants (volatiles, base-neutral acid extractable compounds, and pesticides/PCBs). Analytical results or organic analyses are not tabulated in this report but can be summarized as follows.

1. Five volatile compounds (toluene, methylene chloride, benzene, acetone, 1,2-dichloroethene) were found in one or more samples at very low concentrations. These concentrations were below the contract required detection limit of 10 ppb and cannot be considered significant.
2. Three base-neutral acid extractable compounds were found in one or more samples at very low concentrations. The three compounds were phthalate compounds present at 1 to 2 ppb. These analytical findings were not significant because the compounds were also detected in laboratory blanks or the concentrations found were below the contract required detection limits. Phthalates are common laboratory contaminants.
3. No pesticide or PCB was detected in any of the groundwater samples (RF-MW-01, RF-MW-02, RF-MW-03).

4.3.2 SURFACE WATER

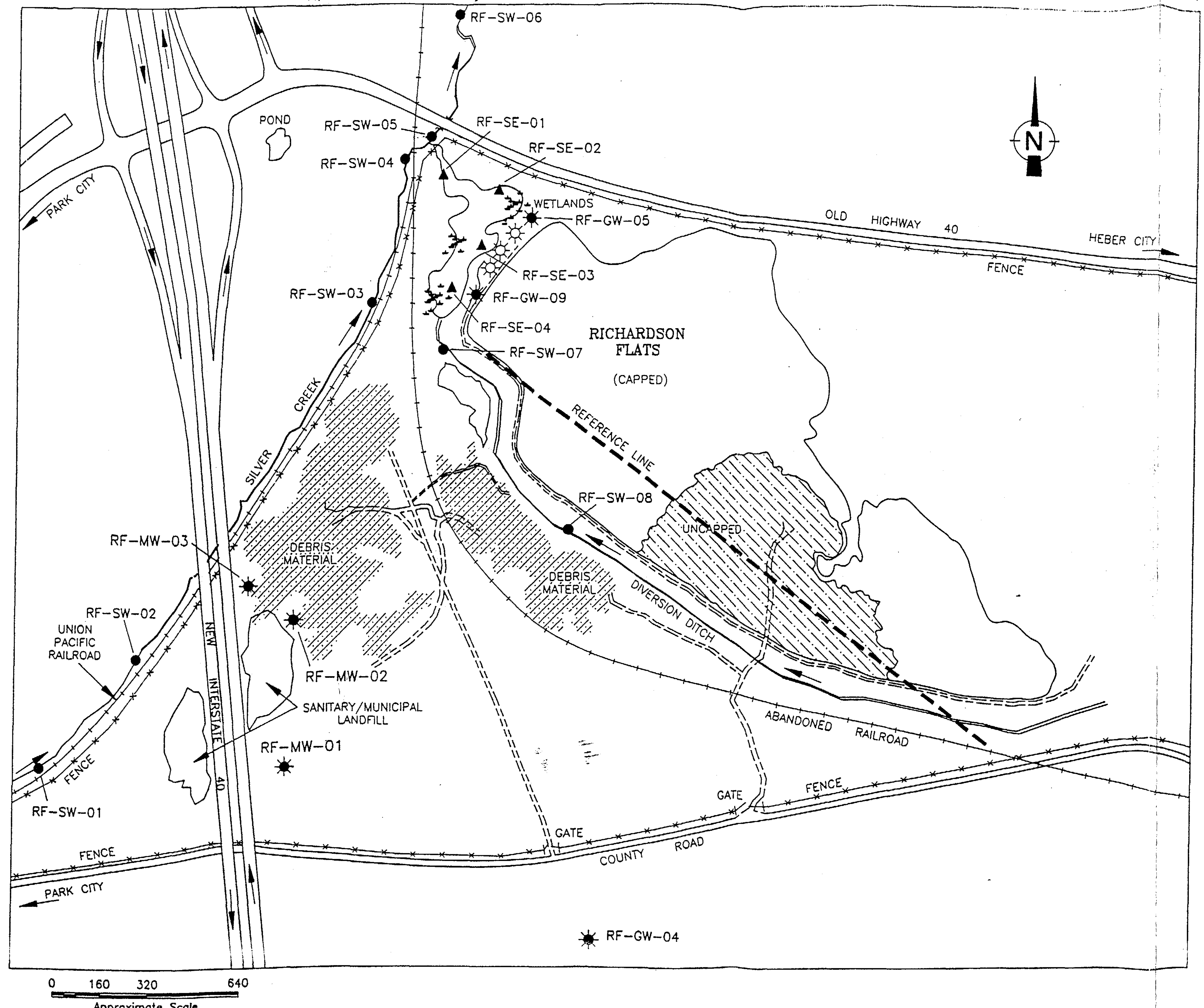
Of the six surface water sample locations shown in Figure 1, two locations (RF-SW-01 and RF-SW-02) were upgradient of the landfill; the other locations were downgradient. Comparison between upgradient and the two closest downgradient samples (RF-SW-03 and RF-SW-04) of inorganic data (Table 3) show no significant increases in contaminant concentrations as Silver Creek flows past the landfill.

These six surface water samples were also analyzed for organics (VOAs, BNAs, Pesticides/PCBs). In all samples no pesticide/PCBs were detected at or above the instrument detection level. One BNA compound, bis(2-ethylhexyl)phthalate, Cas Number 117-81-7, was detected at concentrations between 0.6 and 1 ppb at sample locations RF-SW-01, RF-SW-02, RF-SW-03, and RF-SW-04. This compound is a very common laboratory contaminant. At the very low levels detected its presence cannot be considered significant. Toluene was detected at 3 ppb at three sample locations, RF-SW-01, RF-SW-02, and RF-SW-03. At these very low concentrations the presence of toluene is not a certainty; however because two of the three sample locations were upgradient of the landfill, the presence of this contaminant would not be attributed to the landfill.

In summary, no significant findings came from the organic analyses of surface water samples.

4.4 SITE ACCESS

A security fence has been put in place surrounding the site. Based upon the TAT's inspections and observations during site activities and based upon observations made by UPCM this security fence has been very effective at preventing access to the site. Before the security fence was constructed, the site was most notably used by "off road" motorcycle enthusiasts.



LEGEND

- Approximate location of monitoring wells
- Groundwater sample location
- Surface water sample location
- Sediment sample location

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE, REMOVAL AND PREVENTION
EPA CONTRACT 68-WO-0037

TITLE:
RICHARDSON FLATS
Park City, Utah
SAMPLE LOCATION MAP

T.D.D. T08-9204-015

ecology & environment, inc.
DENVER, COLORADO

FIG. 1

Date: 08/92 Drawn by: RSM Scale:

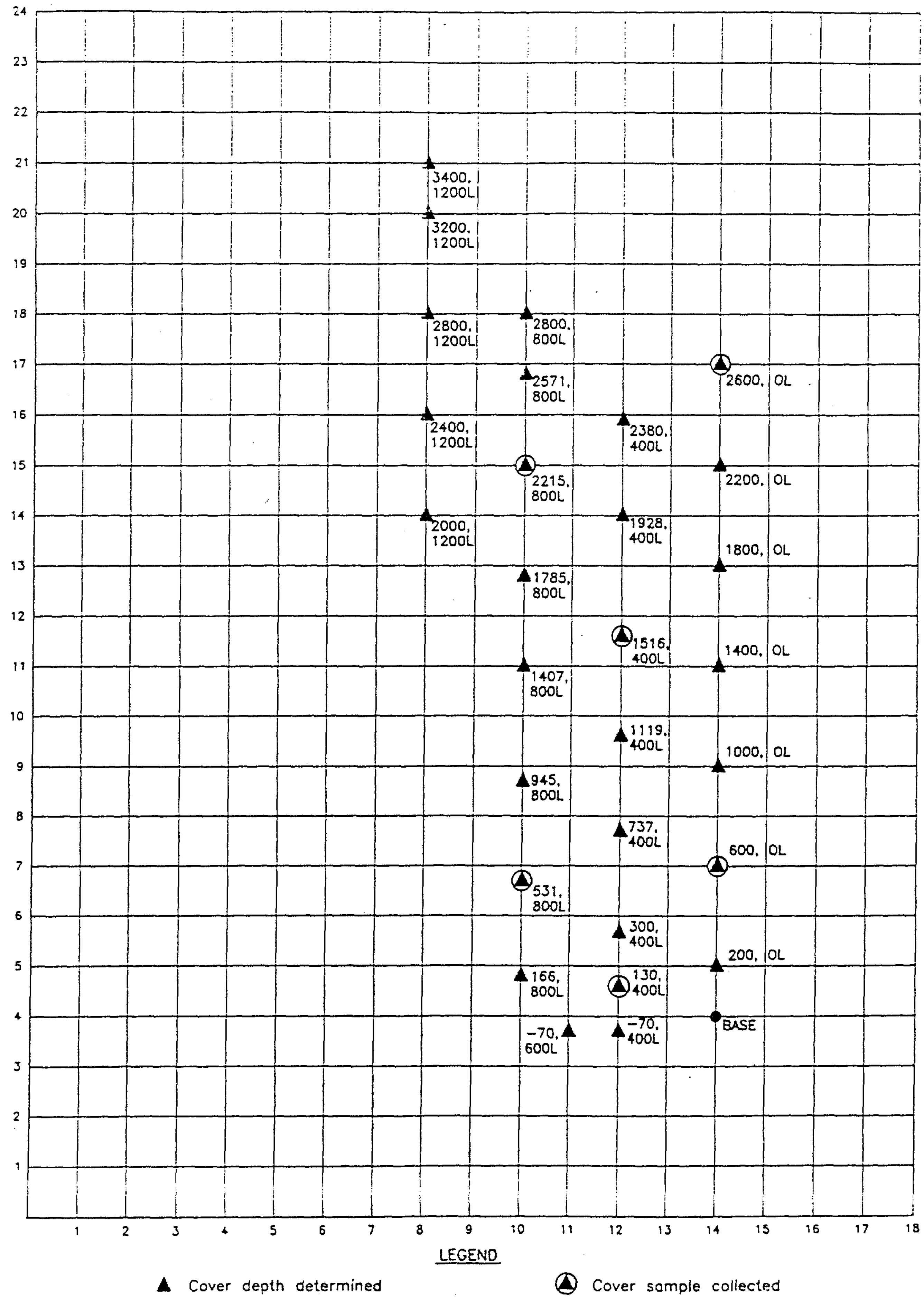


Figure 2
RICHARDSON FLATS

TABLE 1
COVER DEPTH MEASUREMENT
RICHARDSON FLAT TAILINGS SITE
TDD #T08-9204-015

LOCATION	DEPTH OF COVER	VISUAL CONFIRMATION	XRF CONFIRMATION	XRF SAMPLE NUMBERS
200, 0L	10"	Yes	Yes	RF020, 021
600, 0L	3-6"	Yes	Yes	RF022,023,024,025
1000, 0L	>18"			
1400, 0L	>18"			
1800, 0L	>18"			RF026
2200, 0L	0-6"	No	Yes	RF027,028,029,030
2600, 0L	6-10"	Yes	Yes	RF032,033,034,035
2380, 400L	8-9"	Yes	Yes	RF036,037,038,039
1928, 400L	5-6"	Yes	Yes	RF040,041,042
1516, 400L	>6"			
1119, 400L	4"	Yes	Yes	RF044,045
737, 400L	7-8"	Yes	Yes	RF048,049,050
330, 400L	8"	Yes	Yes	RF055,056
2800, 800L	No Cover (Salt Grass)	Yes	Yes	RF057,058,059,060
2571, 800L	No Cover (Salt Grass)	Yes	Yes	RF061,062
2215, 800L	No Cover (Salt Grass)	Yes	Yes	RF063,064
1785, 800L	No Cover (Salt Grass)	Yes	Yes	RF065,066
1407, 800L	3"	Yes	Yes	RF067,068,069
945, 800L	6-7"	Yes	Yes	RF071,072,073
531, 800L	7-8"	Yes	Yes	RF074,075
166, 800L	No Cover	Yes	Yes	RF076,077
130, 400L	2"	Yes	Yes	RF080,081,082
-70, 400L	6.5"	Yes	Yes	RF083,084,085
-70, 600L	11"	Yes	Yes	RF086,087,088,089
2000, 1200L	No Cover (Salt Grass)	Yes	Yes	Rf091,092
2400, 1200L	No Cover (Salt Grass)	Yes	Yes	RF093,094
2800, 1200L	No Cover (Salt Grass)	Yes	Yes	RF095,096
3200, 1200L	No Cover (Salt Grass)	Yes	Yes	RF097,098
3400, 1200L	>10"	Yes	Yes	RF099,100

TABLE 2
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SOIL
CONCENTRATION IN mg/kg
TDD #T08-9204-015

ANALYTE	NORMAL RANGE (mg/kg) *	RF-SO-01	RF-SO-02	RF-SO-03	RF-SO-04	RF-SO-05	RF-SO-06
Aluminum	29000-116000	21200	25300	2960	25800	22000	25200
Antimony	0.22-1.01	5.0U	5.0U	142J	5.0U	5.7NJ	5.6NJ
Arsenic	2.8-10.9	20.9J	3.5J	357J	5.9J	16.6J	8.9J
Barium	337-998	253	282	117	267	317	197
Beryllium	0.30-1.56	1.1	1.1	1.2	1.2	1.1	1.2
Cadmium	0.01-2.0***	3.0J	1.8J	83.0J	1.9J	5.0J	2.4J
Calcium		5850	5900	59200	5900	9480	4920
Chromium	19-90	24.4J	27.9J	12.9J	22.2J	24.3J	28.2J
Cobalt	3.6-14.0	13.9	12.7	12.6	15.0	14.5	10.0B
Copper	10-43	31.4	24.8	454	27.2	50.4	29.4
Iron	10600-41000	21800	25600	67300	23500	27500	23100
Lead	9-31	111	34.9	5770	125J	223	102
Magnesium		4910	5200	10100	5150	4780	5570
Manganese	192-752	1190	637	2020	899	1030	697
Mercury	0.02-0.11	0.11U	0.11U	3.6J	0.10U	0.11U	0.16J
Nickel	7-32	20.7	21.6	18.5	18.4	21.3	19.9
Potassium		4730	4580	917	4330	4540	5650
Selenium	0.09-0.56	0.61U	0.61J	25.4J	0.61U	0.61U	0.61U
Silver	0.01-8***	4.1J	2.0J	20.3J	2.0J	2.0J	2.0J
Sodium		136NJ	319NJ	209NJ	244NJ	248NJ	159NJ
Thallium	0.1-0.8***	0.35NJ	0.43NJ	41.7	0.59NJ	1.9NJ	0.32U
Vanadium	36-136	41.4	56.3	13.0	51.4	57.4	42.2
Zinc	31-98	214	96.3	10000	127	432	184

* Data From: Shacklette, H.T., and Boerngen J.G., 1984; Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270, 105pp.

*** - Bowen, H.J.M., 1979, Environmental Chemistry of the Elements, Academic Press, NY.

TABLE 3
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SURFACE WATER
CONCENTRATION IN µg/l
TDD #T08-9204-015

ANALYTE	RF-SW-01	RF-SW-02	RF-SW-03	RF-SW-04	RF-SW-05	RF-SW-06	RF-SW-07	RF-SW-08
Aluminum	20.3NJ	70.1NJ	19.3NJ	65.5NJ	17.1U	185NJ	36.7NJ	319
Antimony	36.7NJ	24.8NJ	24.3U	38.7NJ	24.3U	30.1NJ	24.3U	24.3U
Arsenic	4.2NJ	5.2NJ	7.3NJ	7.6NJ	7.2NJ	12.5J	5.7NJ	11.4J
Barium	49.2NJ	54.6NJ	50.5NJ	54.4NJ	65.6NJ	66.0NJ	32.7NJ	54.3NJ
Beryllium	3.4NJ	2.8NJ	2.1NJ	2.1NJ	2.4NJ	0.93NJ	3.2NJ	1.0NJ
Cadmium	3.9NJ	3.3U	3.3U	3.5NJ	3.3U	3.3U	3.3U	3.3U
Calcium	233000	157000	128000	149000	163000	146000	341000	190000
Chromium	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U	7.8U
Cobalt	6.0U	6.0U	6.0U	10.4NJ	6.0U	6.0U	6.0U	6.0U
Copper	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U	20.0U	20.0NJ
Iron	193	158	307	356	279	446	703	1320
Lead	35.3J	18.8J	15.0J	36.4J	151J	33.2J	33.3J	146J
Magnesium	38700	37000	30600	33600	36700	37700	61000	38100
Manganese	249J	495J	458J	438J	269J	399J	9230J	1590J
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U	0.24	0.20U
Nickel	11.1U	25.4NJ	11.1U	11.1U	11.1U	11.1U	12.8NJ	20.9NJ
Potassium	3510NJ	2110NJ	1640NJ	1950NJ	1270NJ	1400NJ	3180NJ	1150NJ
Selenium	15.0U	15.0U	15.0U	15.0U	15.0U	15.0U	15.0U	15.0U
Silver	2.4U	2.4U	2.4U	2.4U	2.4U	10.0N	10.0U	10.0U
Sodium	63600	24500	20900	25500	25900	27600	51200	29500
Thallium	1.6U	1.6U	1.6U	1.6U	1.6U	1.6U	1.6U	1.6U
Vanadium	35.7U	35.7U	35.7U	35.7U	35.7U	35.7U	35.7U	35.7U
Zinc	1110J	2080J	769J	776J	466J	321J	64.2J	745J

TABLE 4
NUMERIC STANDARDS OF QUALITY
SILVER CREEK
STATE OF UTAH
WASTEWATER DISPOSAL REGULATIONS

	DOMESTIC SOURCE (1C) (Max. µg/l)	AQUATIC WILDLIFE (3A) 4 Day Avg./1 Hr. Avg. (µg/l)	AGRICULTURAL (4) (Max. µg/l)	HUMAN HEALTH (B) (µg/l)
Antimony				146
Arsenic	50	190/360 (tri As)	100	.002
Barium	1000			
Beryllium				.0037
Cadmium	10	2.5/12.5[A]	10	10
Chromium	50	11/16 (hex Cr) 480/4035 (tri Cr)[A]	100	50
Copper		28.5/47[A]	200	1000
Iron		1000 (Max.)		
Lead	50	2.5/5.7[A]	100	50
Mercury	2	.012/2.4		.144
Nickel		377/3390[A]		13.4
Selenium	10	5/20	50	10
Silver	50	/24[A]		50
Zinc		254/280[A]		5000

A - Based on hardness level of 280 mg/l as $CaCO_3$.

B - Human health criteria applied to all Class 1C water bodies to protect for the consumption of water and aquatic organisms.

TABLE 5
FEDERAL QUALITY CRITERIA FOR WATER
RICHARDSON FLATS TAILINGS
TDD #T08-9204-015
(Concentration in μg/l Unless Otherwise Stated)

	CRITERIA FOR PROTECTION OF FRESH WATER WILDLIFE		CRITERIA FOR PROTECTION OF HUMAN HEALTH	
	ACUTE CRITERIA	CHRONIC CRITERIA	WATER AND FISH INGESTION	FISH CONSUMPTION ONLY
Antimony	9000*	1600*	1.46	
Arsenic	850 (pent)* 360 (tri)	48 (pent)* 190 (tri)	2.2 ng/l**	17.5 ng/l**
Barium			1 mg/l	
Beryllium	130*	5.3*	6.8 ng/l**	117 ng/l**
Cadmium	12.5A	2.5A	10	
Chromium (hex)	16	11	50	
Chromium (tri)			170 mg/l	3433 mg/l
Copper	46.8A	28.5A		
Iron		1000	0.3 mg/l	
Lead	303A	11.8A	50	
Manganese			50	100
Mercury	2.4	0.012	144 ng/l	146 ng/l
Nickel	3390A	377A	13.4	100
Selenium	260	35	10	
Silver	24A	.12	50	
Thallium	1400*	40*	13	48
Zinc	280A	254A		

From: Quality Criteria for Water, 1986, EPA 440/5-86-001.

A - Calculated based on hardness at 280 mg/l $CaCO_3$.

* - Insufficient data to develop criteria. Value presented is the Lowest Observed Effect Level (LOEL).

** - Human health criteria for carcinogens reported for three risk levels. Values presented is the 10^{-6} risk level.

TABLE 6
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR GROUNDWATER
CONCENTRATION IN µg/l
TDD #T08-9204-015

ANALYTE	RF-GW-04 TOTAL	RF-GW-04 DISSOLVED (FILTERED)	RF-GW-05 TOTAL	RF-GW-05 DISSOLVED (FILTERED)	RF-GW-09 TOTAL	RF-GW-09 DISSOLVED (FILTERED)
Aluminum	15700	191NJ	2690	49.6NJ	1630	68.5NJ
Antimony	24.3U	33.2NJ	24.3U	40.5NJ	28.4NJ	35.9NJ
Arsenic	3.7NJ	3.6U	5.2NJ	3.6U	11.3J	8.8NJ
Barium	196NJ	93.9NJ	99.6NJ	64.NJ	58.3NJ	46.2NJ
Beryllium	1.3NJ	0.90U	3.4NJ	1.8NJ	4.9NJ	3.7NJ
Cadmium	3.3U	3.3U	3.3U	3.3U	3.3U	3.3U
Calcium	42200	43500	191000	196000	318000	365000
Chromium	10.5	7.8U	7.8U	7.8U	7.8U	7.8U
Cobalt	11.0NJ	6.0U	7.5NJ	6.0U	9.0NJ	6.0U
Copper	30.0	171J	30.0	20.0NJ	20.0NJ	20.0U
Iron	14100	151	3180	62.6NJ	3190NJ	2170
Lead	627J	40.9J	15.6J	2.2U	31.0J	2.2U
Magnesium	12200	8380	44200	41800	52500	55000
Manganese	162J	19.5J	890J	684J	6670J	7420J
Mercury	0.20U	0.20U	0.20U	0.20U	0.20U	0.20U
Nickel	13.0NJ	11.1U	11.1U	24.9B	25.6NJ	28.9NJ
Potassium	3970NJ	1360NJ	6060	5530	3290NJ	3010NJ
Selenium	3.0U	3.0U	15.0U	15.0U	15.0U	15.0U
Silver	2.4U	10.0U	2.4U	10.0U	3.3NJ	10.0U
Sodium	16100	16800	38100	35700	48600	49700
Thallium	1.6U	1.6U	1.6U	1.6UW	1.6U	1.6U
Vanadium	35.7U	35.7U	35.7U	35.7U	35.7U	35.7U
Zinc	136J	20.1J	99.5J	14.4NJ	92.5J	13.1NJ

TABLE 7
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR SEDIMENT
CONCENTRATION IN mg/kg
TDD #T08-9204-015

ANALYTE	NORMAL RANGE (mg/kg) *	RF-SE-01	RF-SE-01D	RF-SE-02	RF-SE-03	RF-SE-04
Aluminum	29000-116000	28800	28300	1930	4530	11800
Antimony	0.22-1.01	98.5J	97.2J	85.4J	99.0J	40.1J
Arsenic	2.8-10.9	202J	128J	189J	310J	189J
Barium	337-998	260	307	92.1	157	562
Beryllium	0.30-1.56	2.3	2.2	1.2NJ	1.1NJ	2.3NJ
Cadmium	0.01-2.0***	75.6J	93.1J	52.8J	64.9J	40.3J
Calcium		39800	50800	56300	51000	96000
Chromium	19-90	57.7J	62.4J	15.8J	14.9J	25.0J
Cobalt	3.6-14.0	13.4	20.0	5.8NJ	19.3	10.4NJ
Copper	10-43	571	725	183	313	190
Iron	10600-41000	31400	42800	31100	91900	64400
Lead	9-31	6520	6210	3010	5220	2350
Magnesium		14100	14100	13800	11900	10900
Manganese	192-752	3100	5060	2200	2330	42000
Mercury	0.02-0.11	5.9J	8.2J	2.7J	2.4J	1.3J
Nickel	7-32	41.6	51.2	13.2	21.3	97.2
Potassium		4760	4760	886NJ	1120	2710
Selenium	0.09-0.56	9.9J	14.5J	11.4J	43.1J	12.0J
Silver	0.01-8***	28.2J	41.3J	10.7J	16.3J	8.0J
Sodium		472NJ	555NJ	206NJ	634NJ	1150
Thallium	0.1-0.8***	7.1	7.8	13.6	7.8	6.6
Vanadium	36-136	65.4	70.6	9.5NJ	17.8	28.4
Zinc	31-98	12700	15200	8160	11200	5400

* Data From: Shacklette, H.T., and Boerngen J.G., 1984; Element Concentrations in Soils and Other Surficial Materials of the Conterminous United States, U.S. Geological Survey Professional Paper 1270, 105pp.

*** - Bowen, H.J.M., 1979, Environmental Chemistry of the Elements, Academic Press, NY.

TABLE 8
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR GROUNDWATER - LANDFILL AREA
CONCENTRATION IN µg/L
TDD #T08-9210-041

ANALYTE	RF-MW-01 TOTAL	RF-MW-01 DISSOLVED (FILTERED)	RF-MW-02 TOTAL	RF-MW-02 DISSOLVED (FILTERED)	RF-MW-03 TOTAL	RF-MW-03 DISSOLVED (FILTERED)
Aluminum	4600 J	18.1 UJ	94900 J	1710 J	58000 J	16.3 UJ
Antimony	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U	14.8 U
Arsenic	3.8 J	3.2 U	66.8	24.2	81.1	58.5
Barium	178 J	123 J	1180	125 J	622	84.2 J
Beryllium	0.35 U	0.30 U	4.6 J	0.30 U	3.2 J	0.30 U
Cadmium	1.5 U	1.5 U	38.1	1.5 U	1.5 U	1.5 U
Calcium	102000	100000	320000	298000	230000	209000
Chromium	3.7 J	2.6 UJ	110 J	2.6 UJ	66.7 J	2.6 UJ
Cobalt	1.8 U	1.3 U	44.9 J	15.4 U	36.1 J	3.5 U
Copper	7.4 U	1.9 U	142	1.9 U	51.8 U	1.9 U
Iron	3410	5.8 U	77700	859	58000	5210
Lead	1.6 J	2.9 J	187	1.7 J	29.5	3.9
Magnesium	21900	21000	74800	47800	75800	54300
Manganese	150	74.9	22300	19900	11500	8350
Mercury	0.33	0.17	0.49	0.10 U	0.10 U	0.17
Nickel	2.7 U	2.6 U	93.1	16.4 U	71.2	8.6 U
Potassium	1780 J	1460 J	22100 J	3800 J	12800 J	1070 J
Selenium	3.9 U	3.9 U	19.5 UJ	3.9 U	19.5 UJ	3.9 U
Silver	3.6 U	3.6 U	3.6 U	3.6 U	3.6 U	3.6 U
Sodium	26200	26000	83600	82400	85900	84000
Thallium	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U	3.8 U
Vanadium	6.8 J	3.2 J	149	3.4 J	88.9	2.5 U
Zinc	24.7 U	7.0 U	448	20.6 U	177	5.7 U

TABLE 8 CONT.
RICHARDSON FLATS TAILINGS
INORGANIC ANALYTICAL RESULTS FOR GROUNDWATER - LANDFILL AREA
CONCENTRATION IN μg/L
TDD #T08-9210-041

ANALYTE	RF-MW-03 (DUP.) TOTAL	DISSOLVED (FILTERED)	RF-GW-04 TOTAL	DISSOLVED (FILTERED)	RF-GW-30 (RINSATE BLANK)
Aluminum	44700 J	14.7 UJ	15700	191 B	14.7 UJ
Antimony	14.8 U	14.8 U	24.3 U	33.2 B	17.9 J
Arsenic	81.7	70.0	3.7 B	3.6 U	3.2 U
Barium	514	85.1 J	196 B	93.9 B	1.4 U
Beryllium	2.4 U	0.30 U	1.3 B	0.90 U	0.30 U
Cadmium	1.5 U	1.5 U	3.3 U	3.3 U	1.5 U
Calcium	230000	211000	42200	43500	201 J
Chromium	48.8 J	2.6 UJ	10.5	7.8 U	2.6 UJ
Cobalt	28.2 J	3.5 U	11.0 B	6.0 U	1.3 U
Copper	37.6 U	1.9 U	30.0	171 EN*	1.9 U
Iron	44900	5240	14100	151	18.1 U
Lead	29.9	2.7 J	627 N*	40.9 N*	2.7 J
Magnesium	72000	54900	12200	8380	49.6 U
Manganese	11200	8440	162 E	19.5 E	7.0 U
Mercury	0.10 U	0.10 U	0.20 U	0.20 U	0.10 U
Nickel	55.1	7.2 U	13.0 B	11.1 U	3.4 U
Potassium	10500 J	1060 J	3970 B	1360 B	108 J
Selenium	19.5 UJ	3.9 U	3.0 UNW	3.0 UN	3.9 U
Silver	3.6 U	3.6 U	2.4 UN	10.0 UN	3.6 U
Sodium	87800	84700	16100	16800	259 J
Thallium	3.8 U	3.8 U	1.6 U	1.6 U	3.8 U
Vanadium	69.5	2.6 J	35.7 UN	35.7 UN	2.5 U
Zinc	136	5.7 U	136 EN	20.1 EN	5.7 U

TABLE 9
RICHARDSON FLATS TAILINGS
LIST OF INORGANIC DATA QUALIFIERS
TDD #T08-9204-015

B - Entered if the reported value is less than the Contract Required Detection Limit (CRDL) but greater than or equal to the Instrument Detection Limit (IDL).

E - The reported value is estimated because of the presence of interference. An explanatory note must be included under comments on the Cover Page (if the problem applies to all samples) or on the specific FORM I-IN (if it is an isolated problem).

J - The associated numerical value is an estimated quantity because the reported concentrations were less than the required detection limits or quality control criteria were not met.

N - Matrix spiked sample recovery not within control limits.

S - The reported value was determined by the Method of Standard Additions (MSA).

U - Entered if the analyte was analyzed for but not detected, i.e., less than the IDL.

W - Post digestion spike for Furnace AA analysis is out of control limits (85-115%), while sample absorbance is less than 50% of spike absorbance.

* - Duplicate analysis is not within control limits.

+ - Correlation coefficient for the MSA is less than 0.995.

APPENDIX A

MEMO TO EPA/OSC DATED AUGUST 6, 1992,
INSPECTION OF THE TAILINGS DAM AT RICHARDSON FLATS

ecology and environment, inc.

1776 SOUTH JACKSON STREET, DENVER, COLORADO 80210, TEL. 303-757-4984

International Specialists in the Environment

Memorandum

To: Mike Zimmerman
EPA-OSC
From: Mike Sullivan
TAT Region 8
Date: 8/6/92
Subject: Inspection of the Tailings Dam at Richardson Flats T08-9204-015.

Under TDD# T08-9204-015 the U. S. Environmental Protection Agency (EPA) tasked the Ecology & Environment, Inc. Technical Assistance Team (TAT) to inspect the Tailings Dam at the Richardson Flats Tailings Pond near Park City, Utah and to provide a report on the findings of the inspection. The inspection did not encompass any trenching or boring in the embankment which would be required for a full assessment of the structure. This report relies heavily on the two reports generated by Dames and Moore, Inc., and on a visual inspection of the structure. The Dames & Moore reports are "Report of Embankment and Die Design Requirements Proposed Tailings Pond Development Near Park City, Utah for Park City Ventures Corporation" (1974) and "Report on Tailing Pond Investigation near Park City, Utah for Noranda Mining, Inc" (1980).

BACKGROUND

The Richardson Flats Tailings Pond, located near Park City, Utah, was a tailings pond which received slurried mill and mine wastes from mining operations in the Park City area. Tailings were transported to the pond via a slurry pipeline. According to the historical records, Richardson Flats was originally a flat area with intermittent drainages and Silver Creek running across it. The area was somewhat marshy and boggy. The original tailings dam was constructed of organic soils excavated from the site and piled up to form a small berm. Later raises for the embankment were constructed, as needed, out of sands, gravels, organic silts, as well as rubbish and garbage (Dames & Moore, Inc 1974).

In 1974 Dames & Moore, Inc. was contracted by Park City Ventures Corporation, the owners of the mine, to investigate enlarging the tailings pond. Dames & Moore Inc., was to provide design requirements for the proposed embankments with special attention given to minimizing seepage of contaminated pond effluent from the tailings pond. The investigation program consisted of exploratory boring, test pits, laboratory analysis for strength characteristics of the soils, and analysis of the data to provide design requirements. The report called for construction of a main embankment, a dike along the southern and northern ends of the pond, and construction of a diversion ditch to route runoff away from the pond.

In 1974 the embankments and diversion ditch were constructed, generally in accordance with the requirements as outlined in the Dames & Moore report.

In 1980 Dames & Moore, Inc. again investigated the structure for Noranda Mining, Inc., the new owners of the mine. As stated in the reports introduction the objective of this investigation was to "... assess the overall condition and usefulness of the existing facilities and to determine what measures will be required for long-term tailings disposal from the Park City mine." In this report Dames & Moore noted that enlargement of the embankment had not been ..."built according to recommendations ..." and that the fill was not "...properly engineered during construction.". Specific problems noted by Dames & Moore in the construction of the main embankment included: oversteepened slopes of approximately 1.5:1.0 in many places, no evidence of internal zoning of the embankment (clay core), the recommended drainage zone at the downstream toe was not installed, and that overall compaction of the material in the embankment was poor. Also noted at this time was "... considerable seepage in the form of small seeps and marshy areas on the northwest abutment and at the downstream toe of the main embankment...". The report recommended adding a drainage blanket to the toe of the embankment, flattening the oversteepened slope of the main embankment, and gave construction sequences for adding to the dikes.

FIELD INSPECTION

On August 4, 1992 TATm Sullivan inspected the main abutment of the Tailings Pond. From visual inspection and referencing the cross sections provided in the Dames & Moore report it appears that the dike was raised from the 1980 levels although not to the ultimate design levels. It is probable that the main embankment was also raised at the same time. No data is available on the construction or construction inspection of this last round of construction. The visual inspection also indicated that the oversteepened slope of the main embankment had not been flattened and that the drainage zone at the toe of the main embankment had not been installed.

The Main Embankment-

The main embankment is about 30 feet high with a slope length of approximately 50 feet. The main embankment is oversteep lying at 1.0:1.0 to 1.5:1.0 (run:rise). Approximately 6" of fine dry sand, possibly windblown tailings, was noted under a 3" topsoil cover layer on the downstream face of the embankment. The sand has no strength and will erode quickly if exposed. A 35% to 50% grass cover was on most of the embankment which will help in erosion control. No cracking was evident on the embankment, although the sand layer would tend to hide any small cracking. Also, no bending (bulging) was noted on the embankment.

Toe of the Main Embankment-

Rank vegetation, in the form of willows and trees, is growing at the toe of the dam. Approximately 8" of loamy damp soils are evident on the toe of the dam. The amount of vegetation and the type of soils on the toe of the dam indicate that the area receives a lot of water. As the wet soils were noted approximately 6 to 8 feet above the stream level this water is probably due to seepage under the dam. Other evidence of seepage from the toe of the dam was evident in the form of; soft marshy areas, rank vegetation including willows, loamy soils, damp soils, and areas where water had been standing (although no standing water was observed on August 4th).

The North Abutment-

A swampy, loamy area on the north abutment, adjacent to where the embankment meets the abutment, was noted. The area was well above the toe of the dam at the location of the north monitoring well. The north abutment well recharged well when bailed. These conditions indicate that water seeps around or through the contact between the abutment and the embankment. Under full head conditions (saturated tailings) this could be an area where failure of the embankment could occur.

Crest of the Main Embankment-

The crest is sloped back toward the tailings pond allowing any water to drain back to the tailings pond. However, small erosional gullies are forming on the crest and downstream face of the dam and could eventually lead to larger gullying on the dam.

Water Flow-

Water elevations behind the embankment are unknown, however the elevation of water in the ditch and the pond south of the tailings pond are probably indicative of the elevation of groundwater behind the embankment. From the information available in the Dames & Moore, Inc. reports, it is unlikely that a cutoff wall was installed around the perimeter of the pond to control seepage under either the embankment or the dike. The piezometer located on the toe of the dam indicated the water level to be 5 feet below ground. The swampy ground and recharge rate of the monitoring well on the north abutment indicates that water flow from some source is occurring. Inspection of the road cut north of the abutment revealed no seeps. Without further investigation it is conservative to use a worst case scenario and assume that the source of the seep is the water in the tailings behind the dam and that the abutment\embankment contact is a drainage path for the water.

Perimeter Dike-

The perimeter dike was probably constructed by stripping materials off of the downstream side and piling the undifferentiated material up as a dike. The slopes are approximately 2.0:1.0. The dike is used as the access road for the pond and its elevation varies from 2 to 5 feet above the level of the tailings in the pond. The dike appears to be in good condition.

Diversion Ditch-

The diversion ditch has been constructed along the perimeter of the tailings pond as designed by Dames & Moore. The ditch depth and width varies, generally getting deeper and wider as it progresses downstream. Standing water was evident in most of the ditch on the southern perimeter of the property. Rushes, sedges, and cattails were growing in the bottom of the ditch along the entire length. Recent work has been performed by the owners in flattening the ditch banks and adding topsoil to the banks. This work is approximately one-half completed. According to the owners, the rest of the ditch is to be similarly regraded and topsoiled. At the time TAT inspected the site, the hillside diversion ditch, on the north perimeter of the tailings pond, had been cut off from the main ditch as a result of topsoil stripping. This important feature should be reconnected to the main ditch as soon as feasible to prevent additional water flowing into the tailings pond.

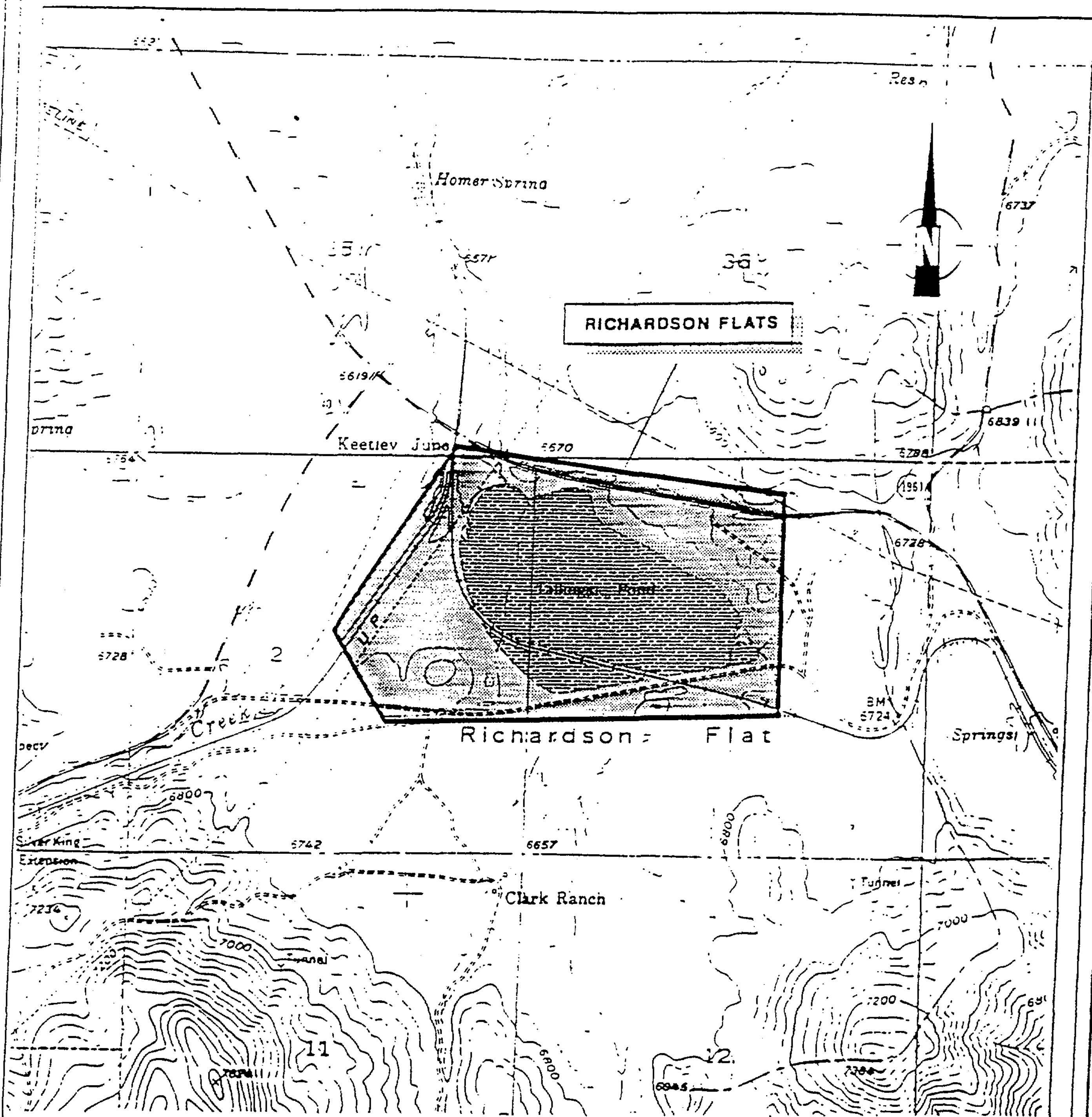
CONCLUSIONS

kBased on TATs inspection, the previous investigation conducted by Dames & Moore, and that the tailings pond seems to be essentially dry, there would appears to be no imminent threat of failure of the main embankment. Failure could occur due to the oversteepened nature of the embankment, especially if the embankment becomes saturated due either to saturation of the tailings or to saturation of the embankment itself. A threat exists of undermining of the dam through the uncontrolled seepage areas located along the toe of the main embankment and on the north abutment. Again the threat would be increased if the tailings become saturated thus increasing the head pressure and possibly the velocity of water flow through the seeps.
The property owners are keeping open the option of reactivating the tailings pond. If the tailings pond is reactivated additional recommended actions are noted in paragraph B. below.

RECOMMENDATIONS

A. Keeping the tailings pond dry through the maintenance of the diversion ditches will do the most to prevent failure of the embankment and a possible release of the tailings into the environment. The connection between the hillside diversion ditch and the perimeter diversion ditch should be restored. In the future, the slopes on the main embankment should be flattened to 2.0:1.0 or greater, and the toe drainage blanket should be installed to allow liquids to drain away from the embankment. A monitoring well should be installed on the top of the tailings pond next to the embankment to monitor the elevation of groundwater within the pond and at the embankment. With water level elevation data available for both upstream of the embankment and at the toe of the embankment better, evaluations of the stability of the structure can be made. If any seeps appear on the embankment they should be monitored for both quantity and quality. Seeps carrying a sediment load generally indicate that active undermining of the embankment may be occurring. Undesirable vegetation in the form of willows and trees should be removed from the embankment.

B. If the pond is to be used for tailings deposition, saturation of the existing tailings is a distinct possibility. With saturation, the possibility of failure of the embankment is raised due to the oversteepened slopes, the existing seeps in the downstream toe of the dam, and the seeps along the north abutment. Saturation of the tailings would increase the head pressure on the seeps, possibly increasing the velocity and amount of water seeping through the embankment. Also, saturation of the tailings will tend to raise the water surface within the embankment itself. Wetting of the material within the embankment can significantly reduce the ability of the material to resist failure. Because the embankment is apparently constructed of undifferentiated materials it would be prudent to add in the drainage blanket at the toe of the embankment and to flatten the embankment as recommended in the 1980 Dames & Moore report. The possibility of a cut-off wall being installed in the embankment should also be investigated. Also, continual monitoring of the seepage from the toe, installation of a network of piezometers and inclinometers is recommended to continually assess the integrity and stability of the embankment.



Source: Park City East Quadrangle, Utah, USGS, 1955

0 1/2 1 MILE

1000 0 1000 2000 3000 4000 5000

LOCATION MAP

LEGEND

Site location

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE, REMOVAL AND PREVENTION
EPA CONTRACT 68-WO-0037

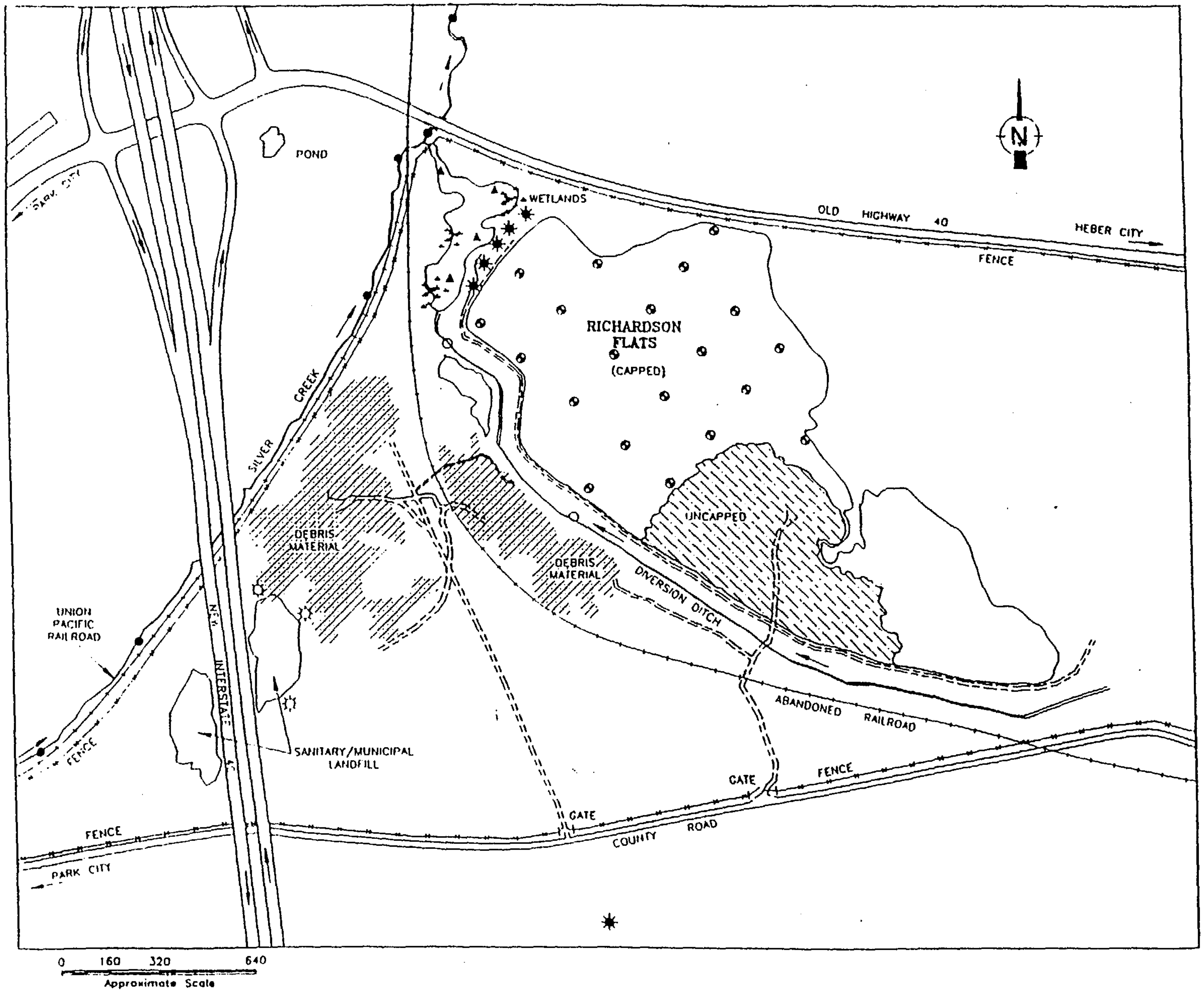
TITLE:

RICHARDSON FLATS
Park City, Utah
SITE LOCATION MAP

T.D.D. T08-9204-015

ecology & environment, inc.
DENVER, COLORADO

FIG. 1



LEGEND

- Approximate location of existing monitoring wells to be sampled
- Proposed monitoring wells to be installed and sampled
- Location of surface water samples from Silver Creek
- Surface water samples from diversion ditch (Two upgradient locations will be determined at the time of sampling in the Northeast portion of the site)
- Location of sediment samples
- Location of soil boring

Note: All air samples will be collected off site

TECHNICAL ASSISTANCE TEAM FOR EMERGENCY RESPONSE, REMOVAL AND PREVENTION
EPA CONTRACT 68-WO-0037

TITLE:
RICHARDSON FLATS
Park City, Utah
SAMPLE LOCATION MAP

T.O.D. T08-9204-015

ecology & environment, inc.
DENVER, COLORADO

FIG. 2

Date: 05/92 Drawn by: RSM Scale:

APPENDIX C: Influence of Tailings Impoundment on Silver Creek Water Quality

APPENDIX C

INFLUENCE OF TAILINGS IMPOUNDMENT ON SILVER CREEK WATER QUALITY

Using water monitoring data from the Site, simple mixing calculations were used to estimate the influence of seepage from the Richardson Flat tailings on the water quality in Silver Creek. The following equation was used:

$$C_{mix} = (C_1 V_1 + C_2 V_2) / (V_1 + V_2)$$

where: C_{mix} = the concentration resulting from mixing two waters (mg/l)
C_1 = the concentration of the first water (mg/l)
V_1 = the flow volume of the first water (cfs)
C_2 = the concentration of the second water (mg/l)
V_2 = the flow volume of the second water (cfs).

As shown in Tables C-1 and C-2, zinc concentrations were calculated for a variety of mixing scenarios. First, water from the south diversion ditch was added to Silver Creek using three scenarios:

- Assuming that Silver Creek meets the AWQ standard (0.37 mg/l)
- Using actual zinc concentrations for samples from Silver Creek upstream of the Site collected May 19, 1999 (Table C-1)
- Assuming Silver Creek zinc concentrations were 0.00 mg/l

Second, seepage from the tailings embankment was added to Silver Creek at various seepage zinc concentrations and seepage flow rates (Table C-2).

Second, seepage from the tailings embankment was added to Silver Creek at various seepage zinc concentrations and seepage flow rates (Table C-2).

Mixing water from the south diversion ditch with Silver Creek (Table C-1) resulted in water with slightly lower zinc concentrations because the zinc concentration (i.e., 0.15 mg/l) in diversion ditch water was lower than the AWQ standard (i.e., 0.37 mg/l) or the measured upstream concentration (i.e., 0.51 mg/l) in Silver Creek. The result from sampling downstream (i.e., 0.49 mg/l) in Silver Creek on May 19, 1999 (see Table 3.4) is almost identical to the calculated value of 0.48 mg/l, suggesting that water from the tailings Site is actually slightly diluting the zinc concentrations in the creek. When Silver Creek zinc concentrations were assumed to be 0.00 mg/l, diversion ditch zinc concentrations of 4.1 mg/l were necessary to reach the AWQ limit. Measured zinc concentrations have never been this high in the ditch.

Mixing seepage from the tailings embankment with Silver Creek (Table C-2) using a variety of zinc concentrations and seepage rates results in no significant change in the zinc concentration in the creek. As shown in Table C-2, the zinc concentrations of the seepage were varied from 1.9 mg/l, the highest concentrations measured between 1991 and 1998 in the five monitoring wells, and 0.165 mg/l, the average concentration calculated from 87 samples collected from five monitoring wells between 1991 and 1998 (see Table 3.2.). The seepage rates were varied from 0.048 gpm (the highest rate, 63 gpd, calculated by Weston, 1999) to 5 gpm (100 times the highest seepage rate calculated by Weston). Given the very small embankment seepage rates compared with the much larger flow of Silver Creek, the influence of embankment seepage on zinc concentrations is negligible. When assuming that Silver Creek zinc was 0.00 mg/l, in order to meet the AWQ limit, flow rates had to be 0.048 gpm to 5 gpm with zinc

DRAFT

This would essentially have the same result that was calculated by mixing the diversion ditch water with Silver Creek.

Tables C-1 and C-2: Zinc Concentrations

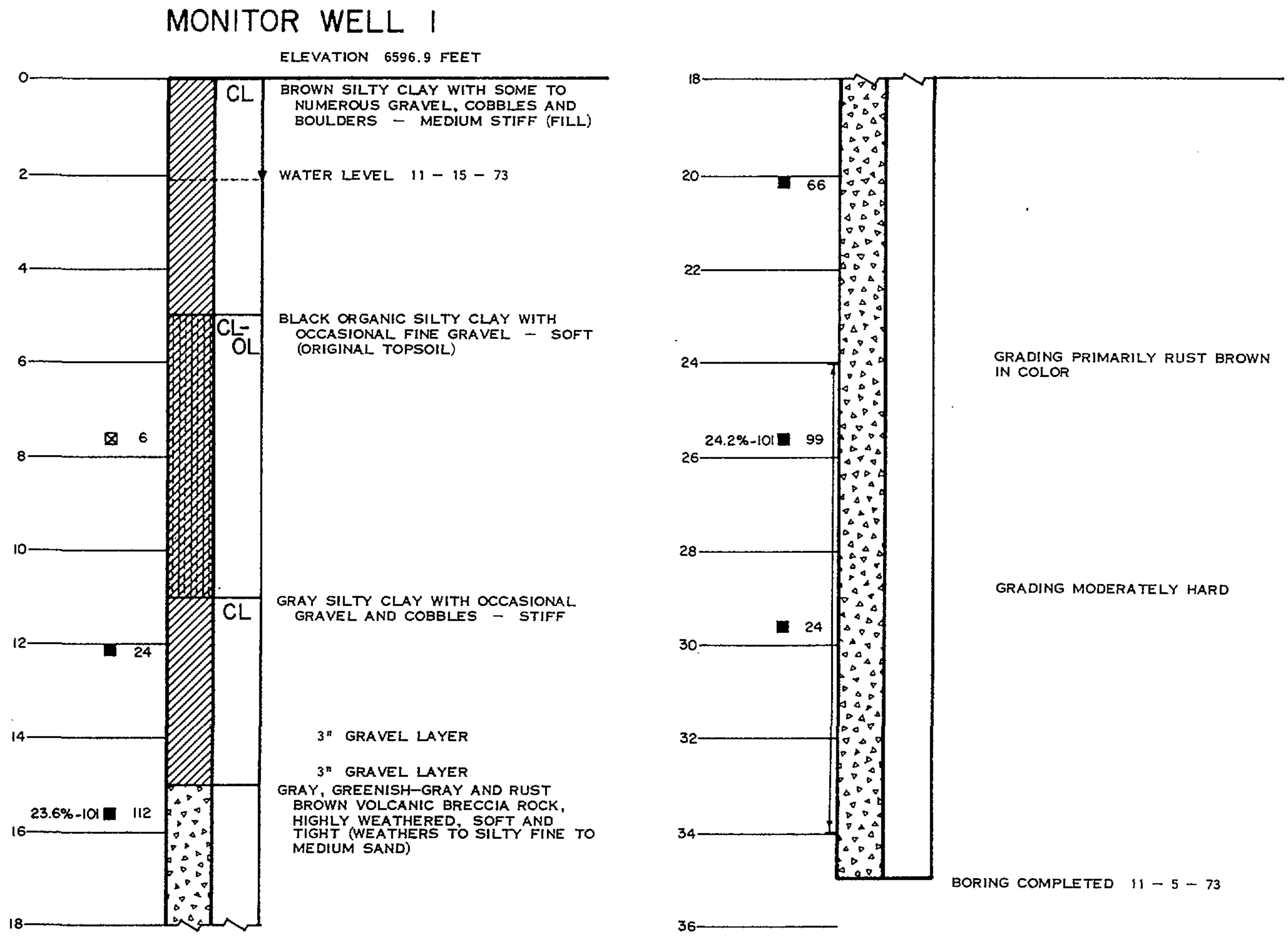
Table C-1: Silver Creek and South Diversion Ditch

Mixing Equation Parameter:	Concentration 1 (mg/l)	Flow Volume 1 (cfs)	Concentration 2 (mg/l)	Flow Volume 2 (cfs)	Mixed Concentration (mg/l)
Water Source:	Silver Creek	Silver Creek	So. Diversion Ditch	So. Diversion Ditch	Silver Creek + So. Diversion Ditch
Notes					
Assuming Silver Creek Meets Standard	0.37	3.17	0.15	0.32	**0.35**
Actual Upstream Silver Creek Conc. (5/19/99)	0.51	3.17	0.15	0.32	**0.48**
Assuming Silver Creek Meets Standard, Increase So. Diversion Ditch Conc. to Increase Silver Creek Conc. by 25%	0.37	3.17	1.4	0.32	**0.46**
Actual Upstream Silver Creek Conc. (5/19/99), Increase So. Diversion Ditch Conc. to Increase Silver Creek Conc. by 25%	0.51	3.17	1.9	0.32	**0.64**
Assuming Silver Creek Contains 0 mg/l Zn, Calculate Zn Conc. Needed in So. Diversion Ditch to Exceed Standard	0	3.17	4.1	0.32	**0.38**

Table C-2: Silver Creek and Embankment Seepage

Mixing Equation Parameter:	Concentration 1 (mg/l)	Flow Volume 1 (cfs)	Concentration 2 (mg/l)	Flow Volume 2 (gpm)	Flow Volume 2 (cfs)	Mixed Concentration (mg/l)
Water Source:	Silver Creek (May 19, 1999)	Silver Creek (May 19, 1999)	Embankment Seepage	Embankment Seepage	Embankment Seepage	Silver Creek + Embankment Seepage
Notes						
Highest Seepage Conc., Highest Seepage Flow (Weston)	0.51	3.17	1.9	0.04375	0.00010	**0.510**
Highest Seepage Flow (Weston)	0.51	3.17	1.0	0.04375	0.00010	**0.510**
Average Seepage Conc., Highest Seepage Flow (Weston)	0.51	3.17	0.165	0.04375	0.00010	**0.510**
Highest Seepage Conc., Seepage Rate 10X Calculated (Weston)	0.51	3.17	1.9	0.5	0.00111	**0.510**
Seepage Rate 10X Calculated (Weston)	0.51	3.17	1.0	0.5	0.00111	**0.510**
Average Seepage Conc., Seepage Rate 10X Calculated (Weston)	0.51	3.17	0.165	0.5	0.00111	**0.510**
Highest Seepage Conc., Seepage Rate 20X Calculated (Weston)	0.51	3.17	1.9	1	0.00223	**0.511**
Seepage Rate 20X Calculated (Weston)	0.51	3.17	1.0	1	0.00223	**0.510**
Average Seepage Conc., Seepage Rate 20X Calculated (Weston)	0.51	3.17	0.165	1	0.00223	**0.510**
Highest Seepage Conc., Extreme High Seepage Rate	0.51	3.17	1.9	5	0.01114	**0.515**
Extreme High Seepage Rate	0.51	3.17	1.0	5	0.01114	**0.512**
Average Seepage Conc., Extreme High Seepage Rate	0.51	3.17	0.165	5	0.01114	**0.509**
Assuming Silver Creek Contains 0 mg/l Zn, Calculate Zn Conc. Needed in Embankment Seepage to Exceed Standard	0	3.17	12400	0.04375	0.00010	**0.38**
Assuming Silver Creek Contains 0 mg/l Zn, Calculate Zn Conc. Needed in Embankment Seepage to Exceed Standard	0	3.17	1080	0.5	0.00111	**0.38**
Assuming Silver Creek Contains 0 mg/l Zn, Calculate Zn Conc. Needed in Embankment Seepage to Exceed Standard	0	3.17	540	1	0.00223	**0.38**
Assuming Silver Creek Contains 0 mg/l Zn, Calculate Zn Conc. Needed in Embankment Seepage to Exceed Standard	0	3.17	108	5	0.01114	**0.38**

APPENDIX D: Boring and Completion Logs for Embankment Monitor Wells



KEY

A – B ■ C

- A FIELD MOISTURE EXPRESSED AS A PERCENTAGE OF THE DRY WEIGHT OF SOIL
- B DRY DENSITY EXPRESSED IN LBS. PER CUBIC FOOT
- C BLOWS PER FOOT OF PENETRATION USING A 140 LB. HAMMER DROPPING 30 INCHES
- ■ DEPTH AT WHICH UNDISTURBED SAMPLE WAS EXTRACTED
- ⊠ DEPTH AT WHICH DISTURBED SAMPLE WAS EXTRACTED
- ↕ SCREENED AND GRAVEL PACKED

NOTES

THE DISCUSSION IN THE TEXT UNDER THE SECTION TITLED, "SITE CONDITIONS, SUBSURFACE", IS NECESSARY TO A PROPER UNDERSTANDING OF THE NATURE OF THE SUBSURFACE MATERIALS.

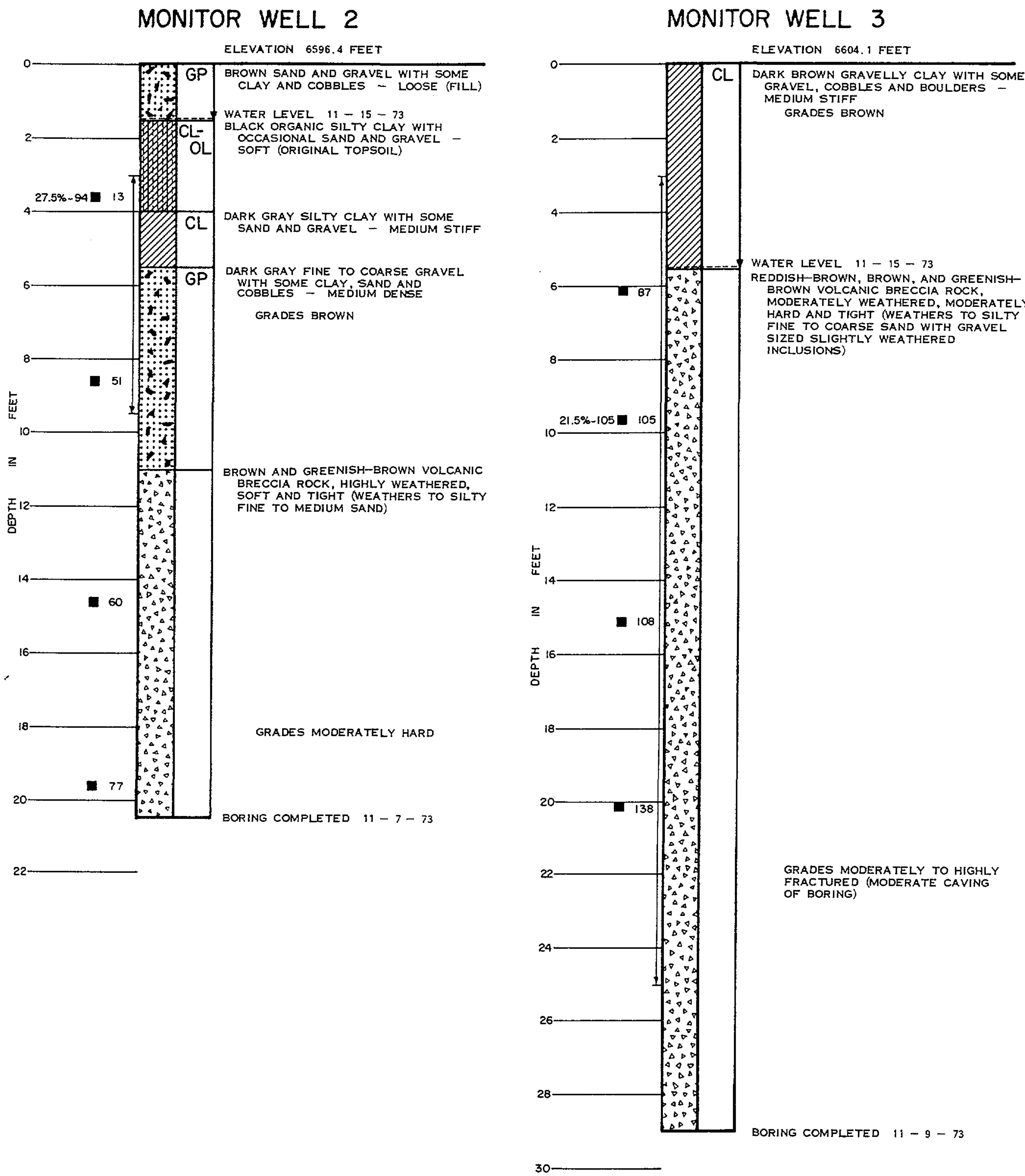
ZONE OF WELL WHICH IS GRAVEL PACKED AND SLOTTED IS INDICATED BY ARROW (↕) TO LEFT OF LOG OF MONITOR WELLS. OTHER ZONES OF WELL SEALED OFF FROM SLOTTED ZONE. SEE TEXT FOR DETAILS.

LOG OF MONITOR WELL

DAMES & MOORE

PLATE ____ OF ____

CHECKED BY CWC DATE 12-3-73



LOG OF MONITOR WELLS

DAMES & MOORE

CHECKED BY ____ DATE ____ PLATE ____ OF ____

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